U.S. Fish & Wildlife Service

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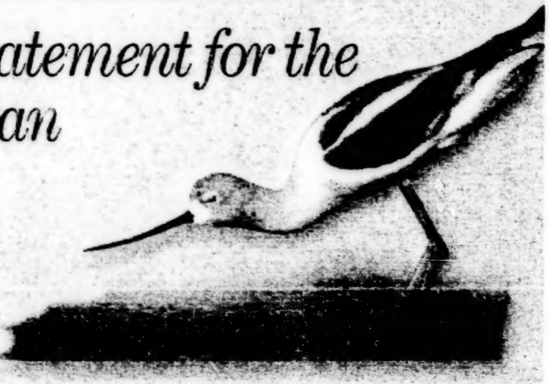
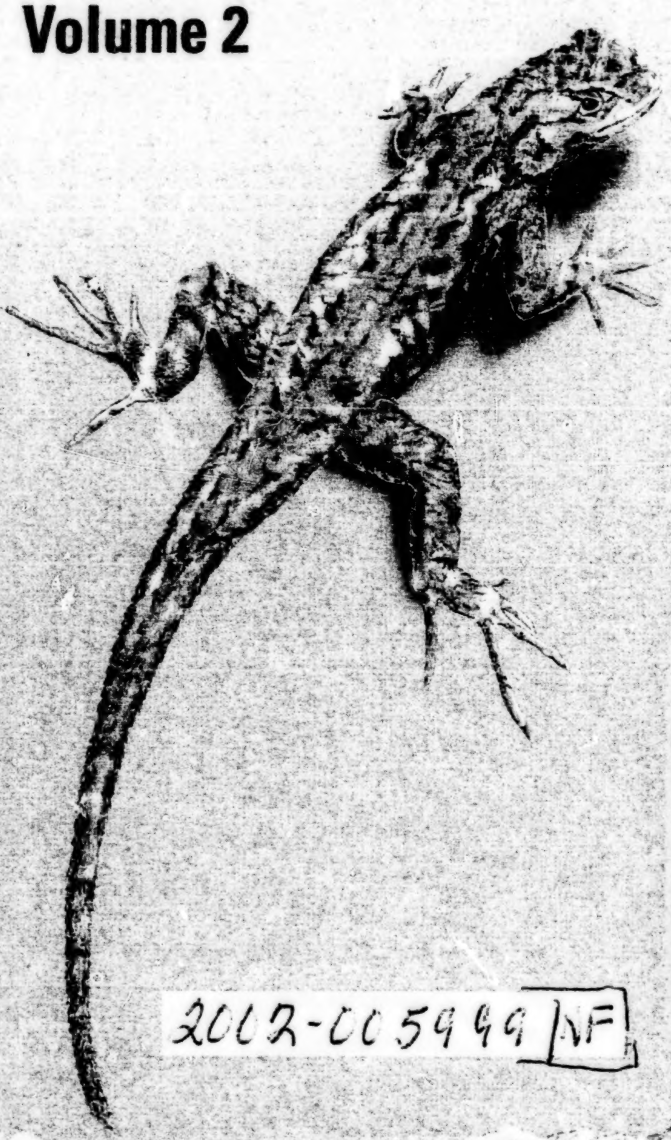
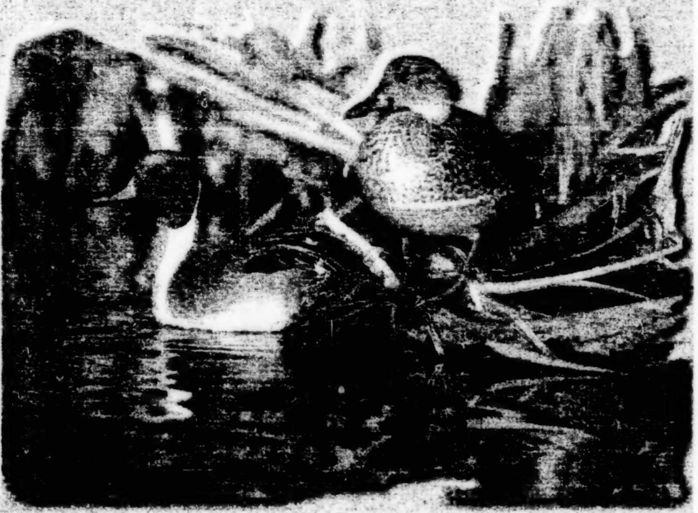
Stillwater National Wildlife Refuge Complex

Draft Environmental Impact Statement for the Comprehensive Conservation Plan and Boundary Revision

Volume 2







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DRAFT ENVIRONMENTAL IMPACT STATEMENT

for the

STILLWATER NATIONAL WILDLIFE REFUGE COMPLEX

COMPREHENSIVE CONSERVATION PLAN and BOUNDARY REVISION

VOLUME II - APPENDICES

March 2000

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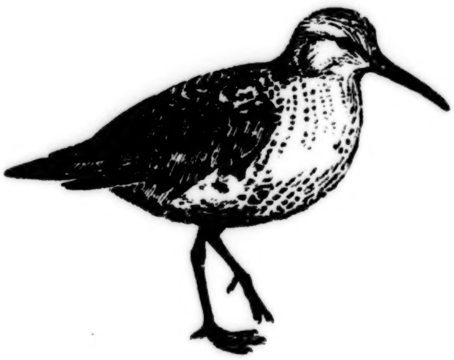

APPENDIX A:
Management Authorities

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Appendix A – Part 1
Management Authorities

AUTHORITIES

The following is a partial list of the more pertinent Acts of Congress, Executive Orders, and treaties that are relevant to the administration and management of the Stillwater NWR Complex. The brief description provided is for informational purposes only. If specific information is necessary, the entire Act, Executive Order, or treaty should be referenced.

LEGISLATION

Antiquities Act of 1906 (16 U.S.C. 431-433; 34 Stat. 255.) The Act requires that a permit be obtained for examination of ruins, excavation of archaeological sites and the gathering of objects of antiquity on lands under the jurisdiction of the Secretaries of the Interior, Agriculture and the Army. This statute also authorizes the President to designate by public proclamation objects or areas of historic or scientific interest as national monuments. The Act authorizes the scientific investigation of antiquities (archaeological, historical, paleontological), subject to the stipulations outlined in permits issued to recognized educational and scientific institutions for the purpose of systematically and scientifically gathering data of scientific value. Paleontological resources fall under the authority of this Act also. (See Refuge Manual, Chapter 5, Part 16, Cultural Resources.)

Archeological and Historic Preservation Act of 1974 (16 U.S.C. 469-469c; 74 Stat. 220), as amended. This Act amends the Reservoir Salvage Act of 1960 to expand its provisions to the preservation of historic and archaeological data in all Federal or Federally assisted or licensed construction projects that might otherwise be lost. This Act directs Federal agencies to notify the Secretary of the Interior whenever they find a Federal or Federally assisted, licensed or permitted project may cause loss or destruction of significant scientific, prehistoric, or archaeologic data. Funds may be appropriated, donated, and/or transferred for the recovery, protection, and preservation of such data. Section 14 directs "The Secretaries of the Interior, Agriculture, and Defense . . . to (a) develop plans for surveying lands under their control to determine the nature and extent of archaeological resources on those lands; (b) prepare a schedule for surveying lands that are likely to contain the most scientifically valuable archaeological resources"; (See Refuge Manual, Chapter 5, Part 16, Cultural Resources.)

Archaeological Resources Protection Act of 1979 (16 U.S.C. 470aa-470ee; 93 Stat. 721). This Act strengthens and expands the protective provisions of the Antiquities Act of 1906 regarding archaeological resources. It replaces the 1906 Act's permitting procedures for archaeological research. (See Refuge Manual, Chapter 5, Part 16, Cultural Resources.)

Bald and Golden Eagle Protection Act of 1972 (16 U.S.C. 668-668d; 54 Stat. 250), as amended. This Act prohibits the taking, possession, sale and transport of bald eagles and golden eagles except in certain circumstances and pursuant to regulations issued by the Secretary of the Interior.

Black Bass Act of 1926 (16 U.S.C. 851-856; 44 Stat. 576), as amended. This Act prohibits the importation or transportation in interstate or foreign commerce of black bass and other game fish in violation of foreign, State, or other law, or the purchase of such fish.

Clean Air Act (1970) and 1977 Amendments (42 U.S.C. 1857-1857f; 69 Stat. 322, and 91 Stat. 685. This Act and its amendments charge Federal land managers with direct responsibility to protect the "air quality and related values" of lands under their control. These values include fish, wildlife, and their habitats. The 1977 amendments establish Class I, II, and III areas where the increase of sulfur dioxide and particulate matter is to be restricted. Mandatory Class I Federal lands include all wilderness areas which exceed 5,000 acres and which were in existence on the date of enactment of the Clean Air Act Amendment of August 7, 1977.

Clean Water Act (1987) and Major Amendments (33U.S.C. 1251-1387). This act and its amendments has as its objective the restoration and maintenance of the chemical, physical, and biological integrity of the Nation's waters. Two goals also were established in the 1972 legislation: zero discharge of pollutants and water quality that is both "fishable" and "swimmable". Section 404 charges the U.S. Army Corps of Engineers with regulating discharge of dredge or fill material into waters of the United States, including wetlands. Section 401 of the Act requires that federally permitted activities comply with the federal Clean Water Act, state water quality laws, and any other appropriate state laws.

Endangered Species Act of 1973 (16 U.S.C. 1531- 1543; 87 Stat. 884), as amended. This Act provides for the conservation of threatened and endangered species of fish, wildlife and plants by Federal action and by encouraging the establishment of state programs. It provides for the determination and listing of endangered and threatened species and the designation of critical habitats. Section 7 of the Act requires refuge managers to perform internal consultation before initiating projects which affect or may affect endangered species.

Truckee-Carson-Pyramid Lake Water Rights Settlement Act of 1990 (Title II of P.L. 101-618; 16 U.S.C. 614 nt 104; Stat 3307). Title II of this Act authorized and directed the Secretary of the Interior to acquire sufficient water and water rights to sustain a long-term average of 25,000 acres of primary wetland habitat in designated Lahontan Valley wetlands. It also expanded the boundary of Stillwater NWR and identified four purposes for which the refuge is to be managed: (A) maintaining and restoring natural biological diversity within the refuge; (B) providing for the conservation and management of fish and wildlife and their habitats; (C) fulfilling the international treaty obligations of the United States regarding fish and wildlife; and (D) providing opportunities for scientific research, environmental education, and fish and wildlife oriented recreation. The Act also authorized the Secretary of the Inerior to recommend to Congress a boundary revision for Stillwater NWR, for which the Act identified criteria. Additional provisions of the Act addressed other water management issues related to the Newlands Irrigation Project.

Federal Aid in Fish Restoration and Management Projects Act of 1950 (16 U.S.C. 777-777k; 64 Stat. 430), as amended. This Act, also known as the Dingell-Johnson Act, provides Federal aid to the states for sport fish restoration. Federal funds from an excise tax on sport fishing tackle are provided to States on a matching basis (75/25) for land acquisition, research, development, and management projects.

Federal Aid in Wildlife Restoration Act of 1937 (16 U.S.C. 669-669i; 50 Stat. 917), as amended. This Act, commonly known as the Pittman-Robertson Act, provides Federal aid to the states for wildlife restoration work. Federal funds from an excise tax on sporting arms and ammunition are provided to States on a matching basis (75/25) for land acquisition, research, development, and management projects.

Federal Insecticide, Fungicide, and Rodenticide Act of 1947 (7 U.S.C. 136-136y; 86 Stat. 975), as amended. Public Law 92-516, approved October 21, 1972, amended the Federal Insecticide, Fungicide, and Rodenticide Act of June 25, 1947 (61 Stat. 163) and established under the Administrator of the Environmental Protection Agency a program for controlling the application of pesticides to assure greater protection to man and the environment.

Federal Land Policy and Management Act of 1976 (43 U.S.C. sections; 90 Stat. 2743. Public Law 94-579, approved October 21, 1976, constitutes an "Organic Act" for the Bureau of Land Management, Department of the Interior. Among other things, it establishes new procedures for creating, modifying, and terminating withdrawals and reservations of public lands. New withdrawals of public lands for refuge purposes are subject to withdrawal procedures of the Act; however, lands so added cannot be removed from the system except by Act of Congress pursuant to the National Wildlife Refuge System Administration Act of 1966.

Federal Property and Administrative Services Act of 1949 (40 U.S.C. 471-535, and other U.S.C. sections; 63 Stat. 378), as amended. The Act, as amended several times, provides for management and disposal of government surplus property (excess property not required for the needs of any Federal agencies) and excess property (property under the control of any Federal agency which is not required for its needs). Public law 94-519, approved October 17, 1976 (90 Stat. 2451), provided major changes to section 203 of the act (40 U.S.C. 484) regarding procedures for disposal of surplus property.

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Federal Noxious Weed Act of 1974 (U.S.C 2801-2813). This Act defines the duties of Federal agencies, and requires that each Federal agency establish and fund an undesirable plant management program, complete and implement cooperative agreements with State agencies, and establish integrated pest management systems to control invasive species.

Federal Water Pollution Control Act Amendment of 1972 (33 U.S.C. 1251-1265, 1281-1292, 1311-1328, 1241-1345, 1361-1376) 86 Stat. 816. The amendments to the Clean Water Act (P.L. 95-217, which amends the Clean Water Act P.L. 92-500), established criteria and performance standards for the restoration and maintenance of the chemical, physical, and biological integrity of the Nation's waters.

Fish and Wildlife Act of 1956 (16 U.S.C. 742a- 742j; 70 Stat. 1119), as amended. Public Law 84-1024 initially established the Fish and Wildlife Service under the Assistant Secretary for Fish and Wildlife and a Commissioner for Fish and Wildlife. The Service consisted of the Bureau of Sport Fisheries and Wildlife and a Bureau of Commercial Fisheries, each having a Director. In 1970, the Bureau of Commercial Fisheries was transferred to the Department of Commerce. (See Refuge Manual, Chapter 1, Part 2, History of Fish and Wildlife Service, for details.) The Act was amended by Public Law 93-271 to abolish the office of Commissioner and establish the U.S. Fish and Wildlife Service under a Director. Under this Act, the Secretary is authorized to take such steps as may be required for the development, advancement, management, conservation, and protection of fish and wildlife resources including, but not limited to, research, development of existing facilities and acquisition by purchase or exchange of land and water or interests therein. The Act also authorizes the Service to accept gifts of real or personal property for its benefit and use in performing its activities and services. Such gifts qualify under Federal income, estate, or gift tax laws as a gift to the United States.

Fish and Wildlife Coordination Act of 1934 (16 U.S.C. 661-666c; 48 Stat. 401), as amended. Public Law 73-121 authorizes the cooperation with other Federal or state agencies and others in the development, protection, rearing, and stocking of fish and wildlife and controlling losses. It also authorizes studies to prevent losses and to enhance fish and wildlife at Federal water resource projects and the use of project lands for wildlife by states and/or the Service (in cases where such lands have value for the national migratory bird management program). Finally, it authorizes Federal water resource agencies to acquire lands specifically for fish and wildlife in connection with water resource projects.

Fish and Wildlife Improvement Act of 1978 (16 U.S.C. 742a; 16 U.S.C. 742f, 16 U.S.C. 7421; 92 Stat. 3110). Public Law 95-616 was passed to improve the administration of fish and wildlife programs and amends several earlier laws including the Refuge Recreation Act, the National Wildlife Refuge System administration Act, and the Fish and Wildlife Act of 1956. It authorizes the Secretary to accept gifts and bequests of real and personal property on behalf of the United States.

Geothermal Steam Act, Section 1013(c) (30 U.S.C. 1001-1021) prohibits geothermal leasing of refuges. Within an approved refuge boundary, the Geothermal Steam Act requires that any geothermal leases that existed leases on Public Land prior to the establishment of an approved refuge boundary or that existed on nonFederal lands prior to their acquisition will remain valid through the duration of the lease.

Historic Sites, Buildings and Antiquities Act of 1935 (16 U.S.C. 461-467; 49 Stat. 666), as amended. This Act of August 21, 1935, also popularly known as the Historic Sites Act, as amended by Public Law 89-249, October 9, 1965 (79 Stat. 971), declares it a national policy to preserve historic sites and objects of national significance, including those located on refuges, for public use. It provides procedures for designation, administration, and protection of sites, and establishes an advisory board. Among other things, national landmarks are designated under authority of this Act, and as of September 1988, 31 national wildlife refuges contained such sites. (See Refuge Manual, Chapter 5, Part 16, Cultural Resources.)

Lacey Act of 1900 (16 U.S.C. 667E, 701; 18 U.S.C. 42-44; 62 Stat. 285), as amended. This Act provides that the responsibilities of the Department of the Interior include preservation, distribution, introduction, and restoration of game birds and other wild birds. It authorizes regulations for the introduction of American or foreign "birds or animals" into new locations and provides criminal penalties for the interstate transportation of wildlife taken in violation of state, Federal, or foreign laws. Also amended by Executive Order 11987, below.

Land and Water Conservation Fund Act of 1965, (16 U.S.C. 460L-4 to 460L-11; 78 Stat 897), as amended. This Act provides funding through receipts from the sale of surplus Federal land, appropriations from oil and gas receipts from the outer continental shelf, and other sources for land acquisition under several authorities.

Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715r; 45 Stat. 1222), as amended. The Bird Conservation Commission which consists of the Secretaries of the Interior (chairman), Agriculture, and Transportation, two members from the House of Representatives, and an ex-officio member from the state in which a project is located. The Commission approves acquisition of land and water, or interests therein, and sizes the prices for acquisition by the Secretary for sanctuaries or for other management purposes. Under this Act, to acquire lands, or interests therein, the state concerned must consent to such acquisition by legislation. Such legislation has been enacted by most states.

Migratory Bird Hunting and Conservation Stamp Act of 1934 (16 U.S.C. 718-718h; 48 Stat. 451), as amended. Public Law 73-124, also known as the Duck Stamp Act, requires waterfowl hunters 16 years of age and older to possess a duck stamp, authorizes the acquisition of lands or interests in lands for waterfowl production areas, and prescribes the use of duck stamp net revenues to acquire migratory bird refuge areas under provisions of the Migratory Bird Conservation Act. As amended, the Act authorizes the sale of duck stamps at refuges as well as other locations. Monies derived from the sale of the stamps are placed in a fund known as the Migratory Bird Conservation Fund, and are supplemented by advance appropriations under the Wetlands Loan Act of 1961, as amended. Approval of the Governor or the appropriate state agency is required for purchases under the Act using the fund.

Migratory Bird Treaty Act of 1918, (16 U.S.C. 703-712;40 Stat. 755), as amended. This Act implements treaties with Great Britain (for Canada), Mexico, Japan, and the Soviet Union for the protection of migratory birds which is designated by this Act as a Federal responsibility. The Act is the basis for setting and enforcing hunting seasons and regulations for migratory birds. It authorizes the Secretary to close areas, Federal or non-Federal, to the hunting of migratory birds.

National Environmental Policy Act of 1969, (43 U.S.C. 4321-4347; 83 Stat. 852). This Act requires the preparation of an environmental impact statement for major Federal actions significantly affecting the quality of the human environment. An impact statement must include impacts of the proposed action as well as of alternatives, including no action. Section 101 (b) " . . ." It is the continuing responsibility of the Federal government to use all practicable means . . . to improve and coordinate Federal plans, functions, programs and resources to the end that the Nation may: (4) preserve important historic, cultural, and natural aspects of our national heritage . . ." Regulations for implementation of the National Environmental Policy Act are found in 40 CFR Parts 1500-1508 (1978). (See Refuge Manual, Chapter 4, Part 5, National Environmental Policy Act Compliance.)

National Historic Preservation Act of 1966, (NHPA) (16 U.S.C. 470-470b, 470c-470n; 80 Stat. 915; 90 Stat. 1319), as amended. Public Laws amending this Act include 89-665, 94-422, 94-458, and 95-515. These Acts are far-reaching and greatly expand Federal policy on archaeological and historic resources. Historic preservation is defined as the protection, rehabilitation, restoration and reconstruction of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, and culture, including encouraging preservation not only on the national level, but state and local levels. They expand the National Register of Historic Places beyond the scope of the National Historic Landmark program to include resources of state and local significance. The Acts authorize matching grants to states and the National Trust for Historic Preservation for acquisition and development of properties listed in the National Register and for development of historic preservation planning programs.

Section 2 asserts, "it shall be the policy of the Federal Government. . . (a) to provide leadership in the preservation of the prehistoric and historic resources of the United States; (b) administer federally owned, administered, or controlled prehistoric and historic resources in a spirit of stewardship for the inspiration and benefit of present and future generations." (See Refuge Manual, Chapter 5, Part 16, Cultural Resources.)

Section 106 of NHPA - "The head of any Federal agency having direct or indirect jurisdiction over a proposed Federal or federally assisted undertaking . . . shall take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register."

Section 110(a)(2) of NHPA - "Each Federal agency shall establish . . . a preservation program for the identification, evaluation, and nomination to the National Register of Historic Places, and protection of historic properties."

National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee; 80 Stat. 927), as amended. Public Law 89-669 defines the National Wildlife Refuge System as including wildlife refuges, areas for the protection and conservation of fish and wildlife which are threatened with extinction, wildlife ranges, game ranges, wildlife management areas, and waterfowl production areas. The Secretary is authorized to permit any use of an area provided such use is compatible with the major purposes for which such area was established. The purchase consideration for rights-of-way go into the Migratory Bird Conservation Fund for the acquisition of lands. By regulation, up to 40 percent of an area acquired for a migratory bird sanctuary may be opened to migratory bird hunting unless the Secretary finds that the taking of any species of migratory game birds in more than 40 percent of such area would be beneficial to the species. The Act requires an Act of Congress for the divestiture of lands in the system, except (1) lands acquired with Migratory Bird Conservation Commission funds, and (2) lands can be removed from the system by land exchange, or if brought into the system by a cooperative agreement then pursuant to the terms of the agreement

The National Wildlife Refuge System Improvement Act of 1997, the most recent amendment to the National Wildlife System Administration Act, formalized the mission of the Refuge System. This mission is to conserve fish, wildlife, and plants and their habitats. The Act clarified the wildlife-first doctrine of refuges, identified several Secretarial directives . . ."'

Native American Graves Protection and Repatriation Act (NAGPRA) (P.L. 101-601; 25 U.S.C. 3002; 104 Stat. 3050) November 16, 1990. This Act provides protection of Native American graves, and for other purposes;" clarifies the right of ownership of Indian, Alaska Native, and Native Hawaiian (Native American) human remains and artifacts, including funerary objects, religious artifacts, and objects of cultural patrimony, found on Federal or tribal lands; establishes conditions for the excavation or removal of Native American human remains or cultural artifacts, including the consent of the appropriate tribe or Native American organization; establishes notification requirements for the inadvertent discovery of Native American human remains or cultural artifacts on federal or tribal lands; establishes criminal penalties for the sale, purchase, or transport of Native American human remains or cultural artifacts without a legal right of possession; directs federal agencies and museums receiving federal assistance to identify the geographic and tribal origins of human or cultural artifacts in their collections, and require the return of the remains or artifacts to the appropriate tribe or Native American organization upon request; establishes a Department of Interior advisory committee to review the identification and repatriation precesses for Native American human remains and cultural artifacts held by federal agencies and federally assisted museums; and establishes civil penalties for museums failing to comply with requirements of this act.

Refuge Improvement Act of 1997 is the first "organic" act for the National Wildlife Refuge System. The Act amends portions of the National Wildlife Refuge System Administration Act and the Refuge Recreation Act, and reiterates into law Executive Order 12996. The Refuge System Improvement Act requires that comprehensive conservation plans be completed for all refuges within a 15-year period, and requires that refuges be managed according to these plans. The act also requires public involvement in the development of the plans. This act defines a unifying mission for the Refuge System, calls for enhanced consideration of certain wildlife-dependent public uses when compatible, and outlines a specific process by which compatibility determinations should be made.

Refuge Recreation Act of 1962 (P.L. 87-714; 16 U.S.C. 460k-4601-4; 76 Stat. 653), as amended. This Act authorizes the Secretary of the Interior to administer refuges, hatcheries, and other conservation areas for recreational use, when such uses do not interfere with the areas' primary purposes. It authorizes construction and

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maintenance of recreational facilities and the acquisition of land for incidental fish and wildlife oriented recreational development or protection of natural resources. It also authorizes the charging of fees for public use.

Refuge Revenue Sharing Act of 1935 (16 U.S.C. 715s; 49 Stat. 383), as amended. This Act provides for the sharing with counties of revenues from areas solely or primarily administered by the Service. For lands purchased by the Service, the greatest of the following amounts is paid to the counties; 75 cents per acre, or three-fourths of 1 percent of the appraised value of the land, or 25 percent of the net receipts of revenue produced from the land. For Service lands withdrawn from the public domain, the payments to the counties remain at 25 percent of the net receipts. These payments are in lieu of taxes. The Act authorizes appropriations to make up deficiencies if there is insufficient money in the funds to make the payments to the counties.

Refuge Trespass Act of 1909 (18 U.S.C. 41; 62 Stat. 686), as amended. The Act of June 25, 1948, consolidated penalties and provisions of various Acts from 1905 through 1934 which make it unlawful (except in compliance with rules and regulations), to hunt, trap, capture, willfully disturb, or kill any bird or wild animal. It is unlawful to take or destroy the eggs of any such bird or fish on any lands or waters which are set apart or reserved as sanctuaries, refuges, or breeding grounds for such bird, fish or animals under any law of the United states, or willfully injure, molest or destroy any property of the United States on any such lands or waters. The Act specifies a maximum fine of $500 and/or imprisonment for not more than six months.

Solid Waste Disposal Act of 1965 (42 U.S.C. 6901-6987; 90 stat. 2795). The Act established the development of recommended guidelines (sec. 209) for solid waste recovery, collection, separation, and disposal systems, and the Applicability of Solid Waste Disposal Guidelines to Executive Agencies. The reference to the Secretary in this Act means the Administrator of the Environmental Protection Agency.

Wilderness Act of 1964 (16 U.S.C. 1131-1136; 78 Stat. 890). The Act directs the Secretary of the Interior to review, within ten years, every roadless area of 5,000 acres or more and every roadless island regardless of size within the National Wildlife Refuge System and to recommend to the President the suitability of each such area. A detailed discussion of this Act may be found in Refuge Manual, Chapter 6, Part 9.

Wildlife Conservation - Transfer of Certain Real Property (16 U.S.C. 667b). Public Law 80-537 (1948) provides, upon request, that real property which is under the jurisdiction or control of a Federal agency and no longer required by that agency can be transferred as excess land, without reimbursement, to the Department of the Interior if suitable for migratory bird management purposes. It also authorizes the transfer of these same types of lands to state conservation agencies for management of wildlife other than migratory birds.

EXECUTIVE ORDERS

Executive Order 11593 (1971). Protection and enhancement of the cultural environment. This order directs Federal agencies to inventory historic, archaeological, and paleontological properties for inclusion on the National Register of Historic Places and to adopt policies that would contribute to the protection of such resources on non-Federal lands. (See Refuge Manual, Chapter 5, Part 16, Cultural Resources, for details.)

Executive Order 11643 (1972), amended by Executive Orders 11507 and 11282. Prevention, control, and abatement of environmental pollution at Federal facilities. This Order requires Federal agencies to comply with Public Law 92-500 (Federal Water Pollution Control Act Amendments) and gives the details for complying.

Executive Order 11752 (1973), supersedes Executive Orders 11507 and 11282. Prevention, control, and abatement of environmental pollution at Federal facilities. This Order requires Federal agencies to comply with Public Law 92-500 (Federal Water Pollution Control Act Amendments) and gives the details for complying.

Executive Order 11870 (1973), amending Executive Order 11643. This amendment to Executive Order 11643 allows for the experimental use of sodium cyanide for predator control programs on public lands.

Executive Order 11917 (1976), amending Executive Order 11643. Authorizes the head of an agency to authorize use of sodium cyanide in the M-44 device on Federal lands subject to restrictions prescribed by the Environmental Protection Agency, except that use is prohibited in areas where endangered or threatened species might be adversely affected, areas of the National Wildlife Refuge System, and prairie dog towns.

Executive Order 11987 (1977). Exotic organisms. This Order states that Federal executive agencies shall, to the extent permitted by law, restrict the introduction of exotic species into the natural ecosystem on lands and waters that they own, lease or hold for purposes of administration.

Executive Order 11988 (1977). Floodplain management. Each Federal agency shall provide leadership and take action to reduce the risk of flood loss and minimize the impact of floods on human safety, and preserve the natural and beneficial values served by floodplains.

Executive Order 11990 (1977). Protection of wetlands. This Order stresses avoidance to the extent possible, of long- and short-term adverse impacts associated with the destruction and modification of wetlands, and the avoidance of direct or indirect support of new construction in wetlands wherever there is a practicable alternative.

Executive Order 12196 (1980). Occupational safety and health programs for Federal employees. All employing units and authorities of the Federal government shall cooperate with the Secretary of Labor to help him/her adopt safety and health programs.

Executive Order 12996. (1996) Management and General Public Use of the National Wildlife Refuge System

Executive Order 11514, Protection and Enhancement of Environmental Quality, March 5, 1970, as amended by Executive Order 11991, May 24, 1977: Requires Federal agencies to monitor, evaluate, and direct their policies, plans, and programs to protect and enhance the Nation's environmental quality in order to sustain and enrich human life.

Executive Order 13007, 1996. This executive order charges Federal Agencies to accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners and t avoid adversely affecting the physical integrity of such sites.

Invasive Species Executive Order 13112, 1999. This Executive Order (EO) directs Federal agencies to use their authorities to prevent the introduction of invasive species, to control, monitor and to restore native species. The EO establishes a Federal interagency Invasive Species Council (Council), co-chaired by the Secretaries of the Interior, Agriculture, and Commerce and includes State, Treasury, Defense, Transportation and the Environmental Protection Agency. The Council will be directed to create an invasive species management plan. The Secretary of the Interior will establish an advisory committee to provide information and advice for consideration by the Council including recommended plans and actions at the local, state, regional and ecosystem-based levels to achieve the goals of the Management Plan. The Council will act in cooperation with states, tribes, scientific, agricultural organizations, conservation groups and other stakeholders.

Executive Order 11593. The executive order charges Federal agencies to provide leadership in preserving, restoring, and maintaining the Nation's historic and cultural environment.

Executive Order 5606, April 22,1931. The executive order established Fallon NWR ..."as a refuge and breeding ground for birds and wild animals."

Executive Order 1819, September 4, 1913. This executive order established Anaho Island NWR as a " . . . preserve and breeding ground for native birds.

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MAJOR TREATIES

Convention between the United States and the United Mexican States for the Protection of Migratory Birds and Game Mammals. February 7, 1936. Calls for a system for protecting certain migratory birds in the United States and Mexico to be adopted. Allows, under regulation, the rational use of certain migratory birds. Provides for enactment of laws and regulations to protect birds by establishment of closed seasons and refuge zones. Prohibits killing of insectivorous birds, except under permit when harmful to agriculture. Provides for enactment of regulations on transportation of game mammals across the United States-Mexican border.

Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere (United States and 17 other American Republics). April 28, 1941. Protects and preserves in their natural habitat representatives of all species and genera of their native flora and fauna, including migratory birds, and protects regions and natural objects of scientific value. The signatory nations agreed to take certain actions to achieve these objectives, including the adoption of "appropriate measures for the protection of migratory birds of economic or aesthetic value or to prevent the threatened extinction of any given species"

Convention on Biological Diversity. December, 29 1993. Outlines provisions for conserving biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.

Convention of Wetlands of International Importance especially as Waterfowl Habitat. November 10, 1986. Maintains a list of wetlands of international importance and works to encourage the wise use of all wetlands in order to preserve the ecological characteristics from which wetland values derive. The Convention is self-implementing, with the U.S. Fish and Wildlife Service providing U.S. secretariat responsibilities and lead for Convention implementation.

Convention between the United States of America and the Union of Soviet Socialist Republics Concerning the Conservation of Migratory Birds and Their Environment. May 23, 1972. Emphasizes activities related to air and water pollution, enhancement of urban environment, preservation of nature, establishment of preserves, and arctic and subarctic ecological systems. The agreement was most recently renewed in 1987 and is renewable every five years.

Convention on Protection of World Cultural and Natural Heritage. November 18, 1972. For the purpose of this Convention, international protection of the world cultural and natural heritage shall be understood to mean the establishment of a system of international co-operation and assistance designed to support States Parties to the Convention in their efforts to conserve and identify that heritage.

Convention between the Government of the United States of America and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction, and Their Environment. September 19, 1974. Provides for the protection of species of birds which are common to both countries, or which migrate between them by (1) enhancement of habitat, (2) exchange of research data, and (3) regulation of hunting.

Convention between the United States and Great Britain (for Canada) for the Protection of Migratory Birds. October 20, 1916. Adopted a uniform system of protection for certain species of birds which migrate between the United States and Canada, in order to assure the preservation of species either harmless or beneficial to man. Sets certain dates for closed seasons on migratory birds. Prohibits hunting insectivorous birds, but allows killing of birds under permit when injurious to agriculture.

Appendix A – Part 2

SUMMARY OF MANAGEMENT DIRECTION FOR STILLWATER NATIONAL WILDLIFE REFUGE
As Defined by:
Establishing Legislation, Refuge System Mission and Goals,
Service Policy, and International Treaties

INTRODUCTION

Management direction for any given national wildlife refuge (refuge) is primarily determined by its purposes as defined in the refuge's establishing authority (either in legislation or executive order) and the mission of the National Wildlife Refuge System (Refuge System) as defined in the Refuge System Improvement Act of 1997 and Executive Order 12996. It is further clarified and delineated by U.S. Fish and Wildlife Service (Service) policy, legislation, executive orders, and international treaties. Comprehensive conservation planning provides an opportunity to step back and examine the focal point toward which a refuge's management should be directed. One of the major objectives of comprehensive conservation planning is to ensure that management of refuges reflect Service policy, Refuge System goals, and purposes for which individual refuges were established (USFWS 1995:602 FW 1.1, 1.3).

This report provides an examination of the management direction of Stillwater National Wildlife Refuge (Stillwater NWR) as delineated by Stillwater NWR purposes, Refuge System mission and other provisions of the Refuge System Improvement Act, other legislation, Executive Orders, Service policy, and international treaties.

Stillwater NWR Purposes

Management of individual refuges is primarily dictated by the purposes for which the refuge was established and the mission of the Refuge System. The Truckee-Carson-Pyramid Lake Water Settlement Act of 1990 (Title II of Public Law 101-618) established Stillwater NWR (§206(b)(2)) to be managed for the purposes of:

(A) maintaining and restoring natural biological diversity within the refuge;

(B) providing for the conservation and management of fish and wildlife and their habitats within the refuge;

(C) fulfilling the international treaty obligations of the United States with respect to fish and wildlife; and

(D) providing opportunities for scientific research, environmental education, and fish and wildlife oriented recreation.

Refuge System Mission

The Refuge System Improvement Act, enacted on October 9, 1997, orders that the mission of the Refuge System is:

> to preserve a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

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Refuge System Goals

Goals of the Refuge System, set by Service policy, more narrowly define the mission of the national network of refuges and are to be used as a guide for developing individual refuge unit goals (602 FW — all refuge goals must support the Refuge System goals. The goals of the Refuge System (602 FW 1.4.M) are:

(1) to preserve, restore, and enhance in their natural ecosystems (when practicable) all species of animals and plants that are endangered or threatened with becoming endangered;

(2) to perpetuate the migratory bird resource;

(3) to preserve a natural diversity and abundance of fauna and flora on refuge lands; and

(4) to provide an understanding and appreciation of fish and wildlife ecology and man's role in his environment and to provide refuge visitors with high quality, safe, wholesome, and enjoyable recreation experiences oriented toward wildlife to the extent these activities are compatible with the purposes for which the refuge was established.

DISCUSSION OF MANAGEMENT DIRECTION BY PURPOSE

A. Restoration and Maintenance of Natural Biological Diversity

The first listed purpose of Stillwater NWR is to restore and maintain natural biological diversity within the refuge. Direction provided by this purpose is reinforced by Executive Order 12996, Refuge System goals, Service policy, and international treaties.

This purpose generally fits within the framework of the mission of the Refuge System as defined in the Refuge System Improvement Act and Executive Order 12996. The Refuge System Improvement Act also directs the Secretary of the Interior to ensure that the biological integrity and environmental health of the Refuge System is maintained, which is closely linked to the restoration and maintenance of natural biological diversity. The Refuge System Improvement Act directs the Secretary to plan and direct the continued growth of the Refuge System in part to contribute to the conservation of ecosystems of the United States. This is relevant to the authority provided by Public Law 101-618 (§206(b)(5)) to revise the boundary of Stillwater NWR as may be appropriate to carry out the purposes of the refuge (e.g., restore and maintain natural biological diversity).

The third listed goal of the Refuge System is "to provide a natural diversity and abundance of fauna and flora on refuge lands." Similarly, it is the policy of the Service that individual refuge units be managed for a natural diversity of native fish, wildlife, and habitats to the extent that it does not conflict with the purposes for which the refuge was established (USFWS 1982:6 RM 1.3, 7 RM 1.3, 7 RM 3.2).

Specific to marsh and water management, it is the policy of the Service to manage marsh and water to meet the needs of the entire marsh community (USFWS 1982:6 RM 2.1), which also is complimentary with the management for a natural diversity within natural biological communities, as are the Service's marsh and water management objectives. Wildlife- and habitat-oriented objectives for marsh and water management are:

(A) To provide habitat for waterfowl, other migratory birds, and endangered or threatened species of plants and animals.

(B) To maintain wildlife diversity in the marsh.

(C) To provide, enhance, and maintain habitat for indigenous species of wildlife and plants.

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Service policy on the management of migratory birds also is complimentary with the purposes of restoring natural biological diversity on the refuge. To the extent that it does not conflict with refuge purposes, a natural diversity of migratory birds, including waterfowl, is to be emphasized. Service policy on non-waterfowl migratory birds directs that refuges be managed in a way that maintains these bird populations at levels consistent with their role in the ecosystem (USFWS 1982:7 RM 4.3), implying conditions that would occur naturally. Specific to waterfowl, Service policy specifies that management of waterfowl on a refuge must be compatible with the purposes for which the refuge was established and meet general criteria for maintaining natural diversity, among other requirements (USFWS 1982:7 RM 3.1).

Most obligations of international treaties with respect to wildlife habitat emphasize the protection and restoration of natural ecosystems and the natural habitats of species receiving management attention: the migratory bird treaties with Japan and the [former] Soviet Union (1974 and 1976, respectively), Convention on Biological Diversity (1992), Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere (1941), and Convention on Protection of World Culture and Natural Heritage (1973). These are discussed in more detail in a later section.

B. Conservation and Management of Wildlife and their Habitat

The second listed purpose of Stillwater NWR is to provide for the conservation and management of fish and wildlife and their habitat. This parallels the fundamental mission of the Refuge System, which is the conservation of fish, wildlife, plants, and their habitat (House Report 105-106). Wildlife can be conserved in a variety of ways, ranging from providing for the needs of a handful of species by maximizing the quality and juxtaposition of resources (high intensity management), to maximizing wildlife diversity through habitat alterations, to conserving a natural diversity of wildlife by restoring natural habitat conditions, to protecting habitat through custodial maintenance (low intensity management). The second purpose of Stillwater NWR, therefore, does not identify any particular direction on how wildlife and their habitat are to be conserved and managed on the refuge and thus it merely reaffirms the Refuge System's mission for all national wildlife refuges. Furthermore, there are a number of approaches that could be taken under "conserving and managing wildlife" that could conflict with other refuge purposes. However, focusing on the approximation of natural biodiversity (first purpose) would avoid this conflict. Service policy calls for the restoration and maintenance of natural diversity to the extent that this would not conflict with refuge purposes. Not only is the restoration of natural biodiversity a viable means to conserve and manage wildlife on the refuge, this approach parallels obligations outlined in international treaties (third purpose). Under the preferred alternative, wildlife and their habitat would be conserved and managed at Stillwater NWR (second purpose), and this will be done primarily by approximating as close as possible the natural diversity of fish, wildlife, plants, and their habitat on the Refuge (first purpose) and by fulfilling international treaty obligations with respect to fish and wildlife (third purpose). Nevertheless, flexibility would be maintained to allow managers to provide for the needs of particular species, when necessary, even if this would reduce natural biological diversity.

C. Fulfillment of International Treaties

The third listed purpose of Stillwater NWR is to fulfill international treaty obligations of the United States with respect to fish and wildlife.

The most well known international treaties are the migratory bird treaties. Most obligations of the migratory bird treaties relate to the protection of migratory birds through regulations on "taking." As such, most obligations are primarily relevant to hunting and law enforcement programs (e.g., hunting regulations). However, several obligations included in the treaties with Japan and the former Soviet Union address habitat protection and management, and, therefore, are more generally applicable to wildlife management programs of individual refuges. Both of these treaties obligate the United State to protect and enhance the environment of migratory birds and prevent and abate the pollution and detrimental alteration of that environment. The most specific obligation with respect to refuges was outlined in the treaty with the former Soviet Union: establish refuges and other protected areas for the conservation of migratory birds and their environment, and manage such areas so as to preserve and restore the natural ecosystems (Article VII of Convention between the United States of America and the Union of Soviet Socialist Republics Concerning the Conservation of Migratory Birds and Their Environment, 1976).

With respect to habitat protection and management, the U.S. has the following obligations under the Convention on Biological Diversity (1992): to protect ecosystems and natural habitats, maintain viable populations of species in natural surroundings, restore degraded ecosystems, promote the recovery of threatened species, prevent the introduction of or eradicate exotic species that threaten ecosystems or species, manage uses in a way that is compatible with the conservation of biological diversity. An obligation that has relevance to the boundary revision assessment for Stillwater NWR is the establishment of a system of protected areas or areas where special measures need to be taken to conserve biological diversity.

The Convention on Wetlands of International Importance especially as Waterfowl Habitat (1971) obligates the U.S. to promote wise use of wetlands and, on appropriate wetlands, increase populations of birds ecologically dependent on wetlands.

One of the two purposes of the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere (1941) is "...to protect and preserve in their natural habitat representatives of all species and genera of their native flora and fauna, including migratory birds..."

An obligation of the U.S. under the Convention on Protection of World Culture and Natural Heritage (1973) is to protect, rehabilitate, and conserve natural features, natural areas, and habitat of threatened species that are of outstanding universal value from the standpoints of science, conservation, and aesthetics).

Given the emphasis of international treaties on the restoration and protection of natural ecosystems, the first and third purposes of Stillwater NWR appear to be complimentary and compatible.

D. Providing Opportunities for Scientific Research, Environmental Education, and Wildlife-oriented Recreation

The fourth listed purpose is to provide opportunities for scientific research, environmental education, and wildlife-oriented recreation. This purpose fits within the framework provided by the Refuge System Improvement Act, Executive Order 12996, Refuge System goals, Service purposes, and Service policy.

The Refuge System Improvement Act directs the Secretary of the Interior to recognize compatible wildlife-dependent recreational activities as priority general uses of the Refuge System, to give serious consideration to expand opportunities for these uses when they are compatible and consistent with sound principles of fish and wildlife management, and ensure that these uses receive more attention in planning and management within the Refuge system, among other directives.

The fourth listed goal of the Refuge System is:

> *to provide an understanding and appreciation of fish and wildlife ecology and man's role in his environment and to provide refuge visitors with high quality, safe, wholesome, and enjoyable recreational experiences oriented toward wildlife to the extent that these activities are compatible with the purposes for which the refuge was established.* (USFWS 1982:2 RM 1.4)

These provide clear direction for targeting wildlife-dependent recreation and education on Stillwater NWR. Service policy further emphasizes and clarifies this mission -- it is the policy of the Service that wildlife/wildland oriented public use be encouraged on refuges when funds are available to support such use and where such activities are compatible with refuge purposes (USFWS 1985:8 RM 1.3). Service policy recognizes that through careful planning, the Service can protect fish and wildlife resources while providing substantial educational and recreational opportunities to the visiting public. However, special attention should be directed toward assuring that all public uses are compatible with the refuge's primary purposes (USFWS 1985:8 RM 1.3). Furthermore, the National Wildlife Refuge System Administration Act of 1966 and the Refuge Recreation Act of 1962 mandate that only public uses that are shown to be compatible with the purposes of the refuge are to be permitted on refuges.

In the case of Stillwater NWR, public uses must be compatible with the restoration and maintenance of natural biological diversity, the conservation and management of fish and wildlife and their habitat, and the fulfillment of international treaty obligations with respect to wildlife. Obviously, providing opportunities for wildlife-oriented research, education, and recreation is compatible with the fourth purpose for which Stillwater NWR was established.

Wildlife-dependent recreation is defined as voluntary, leisure time pursuits which require the presence of, or proximity to, fish or wildlife, or, is in direct, requisite support of activities requiring the presence of, or proximity to, fish or wildlife. It includes, but is not limited to, hunting, fishing, wildlife observation, wild food gathering, hiking, and nature photography (USFWS 1984:5 AM 2.6). Camping may be permitted only when required to implement or sustain an approved wildlife/wildlands oriented recreation activity (e.g., hunting, birdwatching) when no other alternative is practical (USFWS 1982:8 RM 9). In accordance with compatibility and other requirements, and unless prohibited by statute or regulation, both nonconsumptive and consumptive uses are encouraged. Furthermore, Service policy states that any recreational activity permitted on a refuge will be managed to ensure high quality experiences.

Recreation that is not dependent on the presence of, or proximity to, fish or wildlife include waterskiing, motorized boating, picnicking, and swimming (USFWS 1984:5 AM 2.6). Other examples include snowmobiling, mountain bike riding, motorcycle riding, and ATV (all-terrain vehicle) riding. Service policy directs that non-wildlife/wildlands recreational activities presently occurring on refuges will be de-emphasized and eventually phased out, except when they are mandated by statute. However, recreational activities that fulfill a recognized societal need that cannot be provided off-refuge may continue if sufficient funding exists and the use is demonstrated to be compatible with refuge purposes (USFWS 1985:8 RM 1.3,C).

One of the underlying intents of public use programs on national wildlife refuges is to increase the public's understanding of and appreciation for wildlife and wildlands ecology, wildlife management, and problems facing wildlife and wildlands resources (USFWS 1985:8 RM 1.3, 8 RM 4.2).

Wildlife-dependent education refers to those educational practices that enhance the public's understanding of the relationships between plant and animal populations and their habitat (i.e., wildlife ecology), wildlife management, the relationship between people and the environment, impacts that people have on wildlife resources and other problems facing wildlife resources, and the role that Refuge System's play in wildlife conservation (USFWS 1985:8 RM 1).

Wildlife-dependent research refers to research projects that focus on aspects of wildlife ecology and management. The Service especially encourages research projects that have direct application to the management of Stillwater NWR, but also support research aimed at expanding the body of scientific knowledge about fish, wildlife, and their habitat. Priority will be given to studies that contribute to the enhancement, protection, use, preservation, and management of native wildlife populations and their habitats in their natural diversity (USFWS 1982:4 RM 6.1).

In recognition that natural and social science information is necessary for the proper management of refuges, it is Service policy to encourage research and management studies that produce new information upon which to base management decisions (USFWS 1982:4 RM 6). Service policy also allows refuges to be used for other scientific research when the research is compatible with the purposes of the refuge.

OVERRIDING MANAGEMENT DIRECTION FOR STILLWATER NWR

Public Law 101-618, Refuge System mission and goals, Service policy, and international treaties clearly spell out that the core mission of the Service with respect to Stillwater NWR is to restore and maintain natural biological diversity within the refuge and to provide opportunities for wildlife-oriented research, education, and recreation to the extent that they don't conflict with the restoration and maintenance of natural biological diversity.

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APPENDIX B:
Species Lists for Stillwater NWR, Stillwater WMA, and Fallon NWR

Robert Savannah, USFWS

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BIRD SPECIES
OF
STILLWATER NWR, STILLWATER WMA, AND FALLON NWR

Systematic List

ORDER
FAMILY
Subfamily/Tribe

Common name | Genus species | Occurrence

~ - nonnative

C - common
ER - extremely rare
or accidental
R - rare
U - uncommon
* - nest locally
A - accidental

GAVIIFORMES

GAVIIDAE: LOONS

Common name	Genus species		Occurrence
Pacific loon	*Gavia arctica*		R
Common loon	*Gavia immer*		R

PODICIPEDIIFORMES

PODICIPEDIDAE: GREBES

Common name	Genus species		Occurrence
Clark's grebe	*Aechmophorus clarkii*	*	C
Western grebe	*Aechmophorus occidentalis*	*	C
Horned grebe	*Podiceps auritus*		R
Eared grebe	*Podiceps nigricollis*	*	C
Pied-billed grebe	*Podilymbus podiceps*	*	C

PELECANIFORMES

PELECANIDAE: PELICANS

Common name	Genus species		Occurrence
American white pelican	*Pelecanus erythrorhyncos*	*	C
Brown pelican	*Pelecanus occidentalis*		A

PHALACROCORACIDAE: CORMORANTS

Common name	Genus species		Occurrence
Double-crested cormorant	*Phalacrocorax auritus*	*	C

CICONIIFORMES

ARDEIDAE: HERONS

Great blue heron	*Ardea herodias*	*	C
American bittern	*Botaurus lentiginosus*	*	U
Cattle egret	*Bubulcus ibis*	*	U
Green-backed heron	*Butorides striatus*		R
Great egret	*Casmerodius albus*	*	C
Snowy egret	*Egretta thula*	*	C
Least bittern	*Ixobrychus exilis*	*	R
Black-crowned night heron	*Nycticorax nycticorax*	*	C

CICONIIDAE: STORKS

Marabou stork	*Leptotilos crumeniferus*		ER (escapee)
Wood stork	*Mycteria americana*		ER

PHOENICOPTERIDAE: FLAMINGOS

-American flamingo	*Phoenicopterus ruber*		ER (escapee)

THRESKIORNITHIDAE: IBISES AND SPOONBILLS

White faced ibis	*Plegadis chihi*	*	C

ANSERIFORMES

ANATIDAE: SWANS, GEESE, AND DUCKS

Dendrocygnini: fulvous whistling ducks

Fulvous whistling duck	*Dendrocygna bicolor*		A

Cygnini: swans

Trumpeter swan	*Cygnus buccinator*		R
Tundra swan	*Cygnus columbianus*		C

Anserini: geese

Greater white-fronted goose	*Anser albifrons*		U
Brant	*Branta bernicla*		R
Canada goose	*Branta canadensis*		
Lesser	var. *parvipes*		C
Great Basin	var. *moffitti*	*	C
Cackler	var. *minima*		U
Aleutian	var. *leucopareia*		R
Snow goose	*Chen caerulescens*		C
Ross' goose	*Chen rossii*		U

Anatinae: ducks

Wood duck	*Aix sponsa*	*	U
Northern pintail	*Anas acuta*	*	C
American wigeon	*Anas americana*	*	C
Northern shoveler	*Anas clypeata*	*	C
Green-winged teal	*Anas crecca*	*	C
Cinnamon teal	*Anas cyanoptera*	*	C
Blue-winged teal	*Anas discors*	*	U
Eurasian wigeon	*Anas penelope*		R
Mallard	*Anas platyrhynchos*	*	C
American black duck	*Anas rubripes*		A
Gadwall	*Anas strepera*	*	C
Lesser scaup	*Aythya affinis*		U
Redhead	*Aythya americana*	*	C
Ring-necked duck	*Aythya collaris*		U
Greater scaup	*Aythya marila*		R
Canvasback	*Aythya valisineria*	*	C
Bufflehead	*Brucephala albeola*		C
Common goldeneye	*Brucephala clangula*		U
Barrow's goldeneye	*Bucephala islandica*		R
Oldsquaw	*Clangula hyemalis*		R
Hooded merganser	*Lophodytes cucullatus*		U
White-winged scoter	*Melanitta fusca*		R
Surf scoter	*Melanitta perspicillata*		R
Common merganser	*Mergus merganser*		C
Red-breasted merganser	*Mergus serrator*		R
Ruddy duck	*Oxyura jamaicensis*	*	C

GRUIFORMES

GRUIDAE: CRANES

Sandhill crane	*Grus canadensis*		R

RALLIDAE: RAILS, GALLINULES AND COOTS

American coot	*Fulica americana*	*	C
Common moorhen	*Gallinula chloropus*	*	U
Sora	*Porzana carolina*	*	C
Virginia rail	*Rallus limicola*	*	C

CHARADRIIFORMES

CHARADRIIDAE: PLOVERS

Snowy plover	*Charadrius alexandrinus*	*	U
Mountain plover	*Charadrius montana*		R
Semipalmated plover	*Charadrius semipalmatus*		U
Killdeer	*Charadrius vociferous*	*	C
American golden plover	*Pluvialis dominica*		R
Black-bellied plover	*Pluvialis squatarola*		U

RECURVIROSTRIDAE: STILTS AND AVOCETS

Black-necked stilt	*Himantopus mexicanus*	*	C
American avocet	*Recurvirostra americana*	*	C

SCOLOPACIDAE: SANDPIPERS

Spotted sandpiper	*Actitis macularia*	*	U
Ruddy turnstone	*Arenaria interpres*		R
Sanderling	*Calidris alba*		R
Dunlin	*Calidris alpina*		U
Baird's sandpiper	*Calidris bairdii*		U
Red knot	*Calidris canutus*		R
Stilt sandpiper	*Calidris himantopus*		R
Pectoral sandpiper	*Calidris melanotos*		R
Semi-palmated sandpiper	*Calidris pusilla*		R
Willet	*Catoptrophorus semipalmatus*		U
Common snipe	*Gallinago gallinago*		U
Short-billed dowitcher	*Limnodromus griseus*		R
Long-billed dowitcher	*Limnodromus scolopaceus*		C
Marbled godwit	*Limosa fedoa*		U
Long-billed curlew	*Numenius americanus*	*	U
Red-necked phalarope	*Phalaropus lobatus*		C
Wilson's phalarope	*Phalaropus tricolor*	*	C
Lesser yellowlegs	*Tringa flavipes*		U
Greater yellowlegs	*Tringa melanoleuca*		U
Solitary sandpiper	*Tringa solitaria*		R

LARIDAE: GULLS AND TERNS

Black tern	*Chlidonias niger*	*	U
Herring gull	*Larus argentatus*		U
California gull	*Larus californicus*	*	C
Ring-billed gull	*Larus delawarensis*		U
Glaucous gull	*Larus hyperboreus*		R
Bonaparte's gull	*Larus philadelphia*		R
Franklin's gull	*Larus pipixcan*	*	U
Long-tailed jaeger	*Stercorarius longicaudus*		R
Pomarine jaeger	*Stercorarius pomarinus*		R
Caspian tern	*Sterna caspia*	*	U
Forster's tern	*Sterna forsteri*	*	C
Common tern	*Sterna hirundo*		R
Glaucous-winged gull	Larus glaucescens		R
Thayer's Gull	*Larus thayeri*		R

ALCIDAE: AUKS AND MURRES

Ancient murrelet	Synthliboramphus antiquus		ER

FALCONIFORMES

CATHARTIDAE: VULTURES

Turkey vulture	*Cathartes aura*		C

ACCIPITRIDAE: KITES, HAWKS AND EAGLES

Cooper's hawk	*Accipiter cooperii*		U
Northern goshawk	*Accipiter gentilis*		R
Sharp-shinned hawk	*Accipiter striatus*		U
Golden eagle	*Aquila chrysaetos*	*	U
Red-tailed hawk	*Buteo jamaicensis*	*	C
Rough-legged hawk	*Buteo lagopus*		C
Red-shouldered hawk	*Buteo lineatus*		R
Ferruginous hawk	*Buteo regalis*		U
Swainson's hawk	*Buteo swainsoni*	*	U
Northern harrier	*Circus cyaneus*	*	C
Black-shouldered kite	*Elanus caeruleus*		R
Bald eagle	*Haliaeetus leucocephalus*		U
Osprey	*Pandion haliaetus*	*	U

FALCONIDAE: FALCONS

Merlin	*Falco columbarius*		U
Prairie falcon	*Falco mexicanus*	*	U
Peregrine falcon	*Falco peregrinus*		R
American kestrel	*Falco sparverius*	*	C

GALLIFORMES

PHASIANIDAE: GROUSE

-Chukar	*Alectoris chukar*	*	R
-California quail	*Callipepla californica*	*	C
-Wild turkey	*Meleagris gallopavo*	*	U
-Ring-necked pheasant	*Phasianus colchicus*	*	U

COLUMBIFORMES

COLUMBIDAE: DOVES

Band-tailed pigeon	*Columba fasciata*		R
-Rock dove	*Columba livia*	*	C
White-winged dove	*Zenaida asiatica*		ER
Mourning dove	*Zenaida macroura*	*	C

STRIGIFORMES

TYTONIDAE: BARN OWLS

Barn owl	*Tyto alba*	*	C

STRIGIDAE: OWLS

Northern saw-whet owl	*Aegolius acadicus*		R
Short-eared owl	*Asio flammeus*	*	U

Long-eared owl	*Asio otus*	*	U
Burrowing owl	*Athene cunicularia*	*	U
Great horned owl	*Bubo virginianus*	*	C
Western screech owl	*Otus kennicottii*	*	U

CAPRIMULGIFORMES

CAPRIMULGIDAE: NIGHTJARS

Common nighthawk	*Chordeiles minor*	*	C

APODIFORMES

APODIDAE: SWIFTS

White-throated swift	Aeronautes saxatalis		R
Vaux's swift	*Chaetura vauxi*		R
Black swift	*Cypseloides niger*		R

TROCHILIDAE: HUMMINGBIRDS

Black-chinned hummingbird	*Archilochus alexandri*	*	C
Anna's hummingbird	*Calypte anna*		R
Broad-tailed hummingbird	*Selasphorus platycercus*		C
Rufous hummingbird	*Selasphorus rufus*		U
Calliope hummingbird	*Stellula calliope*		R

CORACIIFORMES

ALCEDINIDAE: KINGFISHERS

Belted kingfisher	*Ceryle alcyon*		U

PICIDAE: WOODPECKERS

Northern flicker	*Colaptes auratus*	*	C
Lewis's woodpecker	*Melanerpes lewis*		U
Downy woodpecker	*Picoides pubescens*	*	U
Hairy woodpecker	*Picoides villosus*		U
Red-naped sapsucker	*Sphyrapicus nuchalis*		R
Yellow-bellied sapsucker	*Sphyrapicus varius*		A

PASSERIFORMES

TYRANNIDAE: FLYCATCHERS

Olive-sided flycatcher	*Contopus borealis*		R
Western wood pewee	*Contopus sordidulus*		U
Western flycatcher	*Empidonax difficilis*		C
Hammond's flycatcher	*Empidonax hammondii*		U
Dusky flycatcher	*Empidonax oberholseri*		U
Willow flycatcher	*Epidonax trailii*		U

Gray flycatcher	*Empidonax wrightii*		U
Ash-throated flycatcher	*Myiarchus cinerascens*		U
Black phoebe	*Sayornis nigricans*		R
Say's phoebe	*Sayornis saya*	*	U
Eastern kingbird	*Tyrannus tyrannus*		R
Western kingbird	*Tyrannus verticalis*	*	C

ALAUDIDAE: LARKS

Horned lark	*Eremophila alpestris*	*	C

HIRUNDINIDAE: SWALLOWS

Cliff swallow	*Hirundo phyrrhonota*	*	C
Barn swallow	*Hirundo rustica*	*	C
Purple martin	*Progne subis*		R
Bank swallow	*Riparia riparia*	*	U
Northern rough-winged swallow	*Stelgidopteryx serripennis*	*	U
Tree swallow	*Tachycineta bicolor*		C
Violet-green swallow	*Tachycineta thalassina*	*	U

CORVIDAE: MAGPIES, CROWS AND JAYS

Scrub jay	*Aphelocoma coerulescens*		U
American crow	*Corvus brachyrhynchos*	*	C
Common raven	*Corvus corax*	*	C
Blue jay	*Cyanocitta cristata*		R
Steller's jay	*Cyanocitta stelleri*		R
Piñon jay	*Gymnorhinus cyanocephalus*		R
Clark's nutcracker	*Nucifraga columbiana*		R
Black-billed magpie	*Pica pica*	*	C

PARIDAE: CHICKADEES AND TITMICE

Mountain chickadee	*Parus gambeli*		U
Plain titmouse	*Parus inoratus*		R

AEGITHALIDAE: BUSHTIT

Bushtit	*Psaltriparus minimus*	*	U

SITTIDAE: NUTHATCHES

Red-breasted nuthatch	*Sitta canadensis*		U
White-breasted nuthatch	*Sitta carolinensis*		U
Pygmy nuthatch	*Sitta pygmaea*		R

CERTHIIDAE: CREEPERS

Brown creeper	*Certhia americana*		R

TROGLODYTIDAE: WRENS

Marsh wren	*Cistothorus palustris*	*	C
Rock wren	*Salpinctes obsoletus*	*	U
Bewick's wren	*Thryomanes bewickii*	*	C
House wren	*Troglodytes aedon*	*	U
Winter wren	*Troglodytes troglodytes*		R

MUSCICAPIDAE: THRUSHES, KINGLETS AND GNATCATCHERS

Hermit thrush	*Catharus guttatus*		U
Swainson's thrush	*Catharus ustulatus*		R
Varied thrush	*Ixoreus naevius*		U
Townsend's solitaire	*Myadestes townsendi*		U
Blue-gray gnatcatcher	*Polioptila caerulea*		U
Ruby-crowned kinglet	*Regulus calendula*		U
Golden-crowned kinglet	*Regulus satrapa*		R
Mountain bluebird	*Sialia currucoides*		R
Western bluebird	*Sialia mexicana*	*	U
American robin	*Turdus migratorius*	*	C

LANIIDAE: SHRIKES

Northern shrike	*Lanius excubitor*		R
Loggerhead shrike	*Lanius ludovicianus*	*	C

MIMIDAE: MOCKINGBIRDS AND THRASHERS

Northern mockingbird	*Mimus polyglottos*	*	U
Sage thrasher	*Oreoscoptes montanus*	*	U

MOTACILLIDAE: PIPITS AND WAGTAILS

American pipit	*Anthus rubescens*		C

CINCLIDAE: DIPPERS

American dipper	*Cinclus mexicanus*		R

BOMBYCILLIDAE: WAXWINGS

Cedar waxwing	*Bombycilla cedrorum*		U
Bohemian waxwing	*Bombycilla garrulus*		R

PTILOGONATIDAE: SILKY-FLYCATCHERS

Phainopepla	*Phainopepla nitens*		ER

STURNIDAE: STARLINGS

~European starling	*Sturnus vulgaris*	*	C

VIREONIDAE: VIREOS

Warbling vireo	*Vireo gilvus*	*	U
Solitary vireo	*Vireo solitarius*		U

EMBERIZIDAE: WARBLERS, SPARROWS, BLACKBIRDS AND ORIOLES

Parulinae: wood warblers

Black-throated blue warbler	*Dendroica caerulescens*		ER
Yellow-rumped warbler	*Dendroica coronata*		C
Black-throated gray warbler	*Dendroica nigrescens*		U
Palm warbler	*Dendroica palmarum*		R
Yellow warbler	*Dendroica petechia*		C
Townsend's warbler	*Dendroica townsendi*		R
Common yellowthroat	*Geothlypis trichas*	*	U
Yellow-breasted chat	*Icteria virens*	*	R
MacGillivray's warbler	*Oporornis tolmiei*		U
Ovenbird	*Seiurus aurocapillus*		ER
American redstart	*Setophaga ruticella*		R
Orange-crowned warbler	*Vermivora celata*		C
Nashville warbler	*Vermivora ruficapilla*		U
Wilson's warbler	*Wilsonia pusilla*		C

Cardinalae: grosbeaks, buntings

Blue grosbeak	*Guiraca caerulea*	*	U
Lazuli bunting	*Passerina amoena*	*	U
Indigo bunting	*Passerina cyanea*		R
Black-headed grosbeak	*Pheucticus melanocephalus*	*	U
Rose-breasted grosbeak	*Pheucticus ludovicianus*		R

Emberizinae: towhees, sparrows

Sage sparrow	*Amphispiza belli*	*	C
Black-throated sparrow	*Amphispiza bilineata*	*	C
Lapland longspur	*Calcarius laponicus*		R
McCown's longspur	*Calcarius mccownii*		R
Lark sparrow	*Chondestes grammacus*		U
Dark-eyed junco	*Junco hyemalis*		C
Lincoln's sparrow	*Melospiza lincolnii*	*	U
Song sparrow	*Melospiza melodia*	*	C
Fox sparrow	*Passerella iliaca*		U
Savannah sparrow	*Passerculus sandwichensis* var. *nevadensis*	*	C
Green-tailed towhee	*Pipilo chlorurus*	*	R
Spotted towhee	*Pipilo maculatus*	*	U
Vesper sparrow	*Pooecetes gramineus*		U
American tree sparrow	*Spizella arborea*		ER
Brewer's sparrow	*Spizella breweri*		U
Chipping sparrow	*Spizella passerina*		U
White-throated sparrow	*Zonotrichia albicollis*		R
White-crowned sparrow	*Zonotrichia leucophrys*		C
Harris's sparrow	*Zonotrichia querula*		ER

Icterinae: blackbirds, orioles

Red-winged blackbird	*Agelaius phoeniceus*	*	C
Tri-colored blackbird	*Agelaius tricolor*		R
Brewer's blackbird	*Euphagus cyanocephalus*	*	C

Northern oriole	*Icterus galbula*	*	U
Brown-headed cowbird	*Molothrus ater*	*	U
Great-tailed grackle	*Quiscalus mexicanus*	*	R
Western meadowlark	*Sturnella neglecta*	*	C
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	*	C

Thraupinae: tanagers

Western tanager	*Piranga ludoviciana*		U

PASSERIDAE: WEAVERS

~House sparrow	*Passer domesticus*	*	C

FRINGILLIDAE: FINCHES

Pine siskin	*Carduelis pinus*		U
American goldfinch	*Carduelis tristis*		U
Lesser goldfinch	*Carduelsi psaltria*		U
Cassin's finch	*Carpodacus cassinii*		U
House finch	*Carpodacus mexicanus*	*	C
Evening grosbeak	*Coccothraustes vespertinus*		U

CHARACTERISTIC MAMMAL SPECIES
OF
STILLWATER NWR, STILLWATER WMA, AND FALLON NWR

ORDER
FAMILY

Common name	*Genus species*	Habitat
Names of species which have been documented on the refuge complex are **bold**.		A - aquatic R - riparian U - upland W - wetland

INSECTIVORA

SORICIDAE: SHREWS

Vagrant shrew	Sorex vagrans	R,W
Northern water shrew	Sorex palustris	R

CHIROPTERA

VESPERTILIONIDAE: PLAINNOSE BATS

Pallid bat	*Antrozous pallidus*	U
Big brown bat	*Eptesicus fucus*	U
Silver-haired bat	*Lasionyeteris nottivagans*	U,R
Hoary bat	*Lasiurus cinereus*	U
California myotis	*Myotis californicus*	U
Long-eared myotis	*Myotis evotis*	U
Little brown myotis	*Myotis lucifugus*	U
Small-footed myotis	*Myotis subulatus*	U
Fringed myotis	*Myotis thysanodes*	U
Long-legged myotis	*Myotis volans*	U
Yuma myotis	*Mytois yumanensis*	U
Western pipistrel	*Pipistrellus hesperus*	U
Western big-eared bat	*Plecotus townsendi*	U
Brazilian free-tailed bat	*Tadarida brasiliensis*	U
Mexican freetail bat	*Tadarida brasiliensis*	U

CARNIVORA

PROCYONIDAE: RINGTAIL CATS AND RACCOONS

Raccoon	*Procyon lotor*	W,R

MUSTELIDAE: MINK, WEASELS, BADGERS AND SKUNKS

Badger	*Taxidea taxus*	U
Longtail weasel	*Mustela frenata*	W,R
Mink	*Mustela vison*	W,R
Spotted skunk	*Spilogale putorius*	U
Striped skunk	*Mephitis mephitis*	U

CANIDAE: COYOTES, WOLVES, AND FOXES

Coyote	*Canis latrans*	U
Kit fox	*Vulpes macrotis*	U

FELIDAE: CATS

Mountain lion	*Felis concolor*	U
Bobcat	*Lynx rufus*	U

RODENTIA

SCIURIDAE: SQUIRRELS

Townsend ground squirrel	*Citellus townsendi*	U
Whitetail antelope squirrel	*Ammospermophilus leucurus*	U

GEOMYIDAE: POCKET GOPHERS

Valley pocket gopher	*Thomomys bottae*	U

HETEROMYIDAE: POCKET MICE, KANGAROO MICE, AND KANGAROO RATS

Ord kangaroo rat	*Dipodomys ordi*	U
Desert kangaroo rat	*Dipodomys deserti*	U
Great Basin kangaroo rat	*Dipodomys microps*	U
Great Basin pocket mouse	*Perognathus parvus*	U
Little pocket mouse	*Perognathus longimembris*	U
Longtail pocket mouse	*Perognathus formosus*	U
Merriam kangaroo rat	*Dipodomys merriami*	U
Ord kangaroo rat	*Dipodomys ordi*	U
Pale kangaroo mouse	*Microdipidops pallidus*	U

CASTORIDAE: BEAVER

Beaver	*Castor canadensis*	A

CRICETIDAE: MICE, RATS AND VOLES

Sagebrush vole	*Lagurus curtatus*	U
Long-tailed vole	*Microtus longicaudus*	U
Mountain vole	*Microtus montanus*	W,U
Bushytail woodrat	*Neotoma cinerea*	U,R
Desert woodrat	*Neotoma lepida*	U
Muskrat	*Ondatra zibethica*	A
Northern grasshopper mouse	*Onychomys leucogaster*	U
Southern grasshopper mouse	*Onychomys torridus*	U
Canyon mouse	*Peromyscus crinitus*	U
Deer mouse	*Peromyscus maniculatus*	U
Pinion mouse	*Peromyscus truei*	U
Western harvest mouse	*Reithrodontomys megalotis*	W,U

MURIDAE: OLD WORLD RATS AND MICE

House mouse	*Mus musculus*	U
Norway rat	*Rattus norvegicus*	U

ZAPODIDAE: JUMPING MICE

Western jumping mouse	*Zapus princeps*	U

ERETHIZONTIDAE: PORCUPINE

Porcupine	*Erethizon dorsatum*	U

LEPORIDAE: HARES AND RABBITS

Blacktail jackrabbit	*Lepus californicus*	U
Mountain cottontail	*Sylvilagus nuttalli*	U

ARTIODACTYLA

CERVIDAE: DEER

Mule deer	*Odocoileus hemionus*	U,R

CHARACTERISTIC REPTILE AND AMPHIBIAN SPECIES
OF
STILLWATER NWR, STILLWATER WMA, AND FALLON NWR

ORDER **FAMILY** Common name	Genus species subspecies	
Names of species which have been documented on the refuge complex are **bold**.		
ANURA		
PELOBATIDAE: SPADEFOOT TOADS		
Great Basin spadefoot toad	*Scaphiopus intermontanus*	
HYLIDAE: TREE FROGS		
Pacific tree frog	*Pseudacris regilla*	
RANIDAE: FROGS		
Bullfrog	*Rana catesbeiana*	nonnative
Northern leopard frog	*Rana pipiens*	
CHELONIA		
TESTUDINIDAE: FRESHWATER TURTLES		
Northwestern pond turtle	*Clemmys marmorata marmorata*	
SQUMATA		
IGUANIDAE: IGUANID LIZARDS		
Northern Desert horned lizard	*Phrynosoma platyrhinos platyrhinos*	
Great Basin collared lizard	*Crotaphytus insularis bicintores*	
Great Basin fence lizard	*Sceloporus occidentalis biseriatus*	
Large-spotted leopard lizard	*Gambelia wislizenii wislizenii*	
Northern sagebrush lizard	*Sceloporus graciosus graciosus*	
Side-blotched lizard	*Uta stansburiana*	
Yellow-backed spiny lizard	*Sceloporus magister uniformis*	
Common Zebra-tailed lizard	*Callisaurus draconoides draconoides*	
TEIIDAE: WHIPTAIL LIZARDS		
Great Basin whiptail lizard	*Cnemidophorus tigris tigris*	

COLUBRIDAE: COMMON SNAKES

California kingsnake	*Lampropeltis getulus californiae*
Desert striped whipsnake	*Masticophis taeniatus taeniatus*
Great Basin gopher snake	*Pituophis melanoleucus deserticola*
Mojave patch-nosed snake	*Salvadora hexalepis mojavensis*
Night snake	*Hypsiglena torquata*
Rocky Mountain rubber boa	*Charina bottae utahensis*
Sierra garter snake	*Thamnophis couchii couchii*
Sonoran Mt. Kingsnake	
Wandering garter snake	*Thamnophis elegans vagrans*
Western yellow-bellied racer	*Coluber constrictor mormon*
Western long-nosed snake	*Rhinocheilus lecontei lecontei*
Western ground snake	*Sonora semiannulata*
Western coachwhip	*Masticophis flagellum testaceus*

VIPERIDAE: PIT VIPERS

Great Basin rattlesnake	*Crotalus viridis lutosus*

CHARACTERISTIC FISH SPECIES
OF
STILLWATER NWR, STILLWATER WMA, AND FALLON NWR

ORDER
FAMILY

Common name	*Genus species*	Native
SALMONIFORMES		
SALMONIDAE: TROUT		
Lahontan cutthroat trout	*Salmo clarki henshawi*	*
Rainbow trout	*Salmo gairdneri*	
CYPRINIFORMES		
CYPRINIDAE: MINNOWS		
Asiatic carp	*Cyprinus carpio*	
Fathead minnow	*Pimephales promelas*	
Goldfish	*Carassius auratus*	
Lahontan tui chub	*Gila bicolor obesus*	*
Lahontan speckled dace[a]	*Rhinichthys osculus robustus*	*
Lahontan red-side shiner	*Richardsonius egregius*	*
Sacramento blackfish	*Orthodon microlepidotus*	
SILURIFORMES		
ICTALURIDAE: CATFISH		
Black bullhead	*Ictalurus melas*	
Brown bullhead	*Ictalurus nebulosus*	
Channel catfish	*Ictalurus punctatus*	
White catfish	*Ictalurus catus*	
PERCOPSIFORMES		
CENTRARCHIDAE: SUNFISH		
Black crappie	*Pomoxis nigromaculatus*	
Bluegill	*Lepomis macrochirus*	
Green sunfish	*Lepomis cyanellus*	
Largemouth blackbass	*Micropterus salmoides*	
Sacramento perch	*Archoplites interruptus*	
Smallmouth blackbass	*Micropterus dolomieui*	
White crappie	*Pomoxis annularis*	

ANTHERINIFORMES

POECILIIDAE: MOSQUITOFISH

Mosquito fish	*Gambusia affinis*

PERCIFORMES

PERCICHTHYIDAE: TEMPERATE BASS

Striped bass	*Morone saxatilis*
White bass	*Morone chrysops*
Wiper	*Morone chrysops* X *saxatilis*

PERCIDAE: PERCH

Walleye	*Stizostedion vitreum*
Yellow perch	*Percan flavescens*

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a. Lahontan Speckled Dace has not been confirmed in 20 years.

SAND OBLIGATE INVERTEBRATE SPECIES
OF
STILLWATER NWR, STILLWATER WMA, AND FALLON NWR

Systematic List

ORDER	*Genus species*
COLEOPTERA	
	Mecynotarsus delicatulus
	Rhadine myrmecodes
	Tetragonoderus pallidus
	Philothris sp.
	Niptus ventriculus
	Aegialia spinosa
	Aphodius parapyriformis
	Chilometopon pallidium
	Edrotes ventricosus
	Eusattus muricatus
	Lariversius tibalis
	Trogloderus costatus
ORTHOPTERA	
	Ammobaenetes lariversi
	Stenopelmatus sp.

Source: (Rust 1998)

BUTTERFLY SPECIES
OF
STILLWATER NWR, STILLWATER WMA, AND FALLON NWR

Systematic List

FAMILY

SUBFAMILY

Common name	*Genus species*
PAPILIONODAE	
PAPILIONINAE: SWALLOWTAILS	
Western Tiger Swallowtail	*Papilio rutulus*
PIERIDAE	
PIERINAE: WHITES	
Becker's White	*Pontia beckerii*
Checkered White	*Pontia protodice*
Western White	*Pontia occidentalis*
Cabbage White	*Pieris rapae*
Large Marble	*Euchloe ausonides*
Sara Orangetip	*Anthocharis sara*
COLIADINAE: SULPHURS	
Clouded Sulphur	*Colias philodice*
Orange Sulphur	*Colias eurytheme*
LYCAENIDAE	
LYCAENINAE: COPPERS	
Purplish Copper	*Lycaena helloides*
THECLINAE: HAIRSTREAKS	
Gray Hairstreak	*Strymon melinus*
POLYOMMATINAE: BLUES	
Western Pygmy-Blue	*Brephidium exile*
NYMPHALINAE: TRUE BRUSH-FOOTS	
Mylitta Crescent	*Phyciodes mylitta*
Mourning Cloak	*Nymphalis antiopa*
Painted Lady	*Vanessa cardui*

West Coast Lady	*Vanessa annabella*
Red Admiral	*Vanessa atalanta*

LIMENITIDINAE: ADMIRALS AND RELATIVES

Lorquin's Admiral	*Limenitis lorquini*

DANAINAE: MONARCHS

Monarch	*Danaus plexippus*

HESPERIIDAE

PYRGINAE: SPREAD-WING SKIPPERS

Common Checkered-Skipper	*Pyrgus communis*
Mohave Sootywing	*Hesperopsis libya*
Saltbush Sootywing	*Hesperopsis alpheus*

HESPERIINAE: GRASS SKIPPERS

Sandhill Skipper	*Polites sabuleti*
Alkali Skipper	*Pseudocopaeodes enus*

WETLAND INVERTEBRATE TAXA
OF
STILLWATER NWR, STILLWATER WMA, AND FALLON NWR

Systematic List

CLASS **ORDER** Common Name	*Family*
INSECTA	
COLLEMBOLA	
Springtail	not determined
COLEOPTERA	
Predaceous diving beetle	Dytiscidae
Water scavenger beetle	Hydrophilidae
DIPTERA	
Midge	Chironomidae
Mosquito	Culicidae
Alkali flies	Ephydriae
EPHEMEROPTERA	
Mayfly	not determined
HEMIPTERA	
Water boatman	Corixidae
Water strider	Gerridae
Back swimmer	Notonectidae
ODONATA	
Dragonfly	Aeschnidae
Dragonfly	Libelullidae
GASTROPODA	
Limnophila	
Pond snail	Lymnaidae
Pouch snail	Physidae
Orb snail	Planorbidae

CRUSTACEA	
Amphipoda	
Scud (or side swimmer)	not determined
Anostraca	
Fairy shrimp	Artemiidae
Cladocera	
Water fleas	not determined
Copepoda	
Copepods	not determined
Ostracoda	
Seed shrimp	not determined
ARACHNOIDEA	
Hydracarina	
Water mite	not determined

WETLAND PLANT SPECIES
OF
LAHONTAN VALLEY

List of all plant species by origin (* - non-native), family, common name, and wetland indicator status for the Lahontan Valley wetland inventory. Nomenclature follows Hickman (1993).

	Genus and species	Family	Common Name	Wetland Status[1]
Trees				
*	*Elaeagnus angustifolius*	Elaeagnaceae	Russian olive	FAC
	Populus fremontii	Salicaceae	Fremont cottonwood	FACW
	Salix exigua	Salicaceae	Sandbar willow	OBL
	Salix laevigata	Salicaceae	Red willow	NI
*	*Tamarix ramosissima*	Tamaricaceae	Saltcedar	FACW
*	*Ulmus pumila*	Ulmaceae	Siberian elm	NI
Shrubs				
	Allenrolfea occidentalis	Chenopodiaceae	Iodine bush	FACW
	Artemisia spinescens	Asteraceae	Bud-sage	NI
	Artemisia tridentata var. tridentata	Asteraceae	Big sagebrush	NI
	Atriplex canescens	Chenopodiaceae	Fourwing saltbush	NI
	Atriplex confertifolia	Chenopodiaceae	Shadscale	NI
	Atriplex lentiformis ssp. torreyi	Chenopodiaceae	Torrey's saltbush	FAC-
	Chrysothamnus nauseosus ssp. consimilis	Asteraceae		NI
	Chrysothamnus nauseosus var. oreophalus	Asteraceae	Rubber rabbitbrush	NI
	Chrysothamnus viscidiflorus	Asteraceae	Stickyleaf rabbitbrush	NI
	Grayia spinosa	Chenopodiaceae	Hop-sage	NI
	Lycium shockleyi	Solanaceae	Wolfberry	NI
	Psorothamnus polydenius	Fabaceae	Dotted dalea	NI
	Rosa woodsii var. ultramontana	Rosaceae	Woods rose	FAC-
	Sarcobatus vermiculatus	Chenopodiaceae	Greasewood	FACU
	Suaeda moquinii	Chenopodiaceae	Torrey's seepweed	FAC+
	Tetradymia glabrata	Asteraceae	Smooth horsebrush	NI
	Tetradymia spinosa	Asteraceae	Spiney horsebrush	NI
	Tetradymia tetrameres	Asteraceae	Dune-horsebrush	NI
Grasses				
	Achnatherum hymenoides	Poaceae	Indian ricegrass	NI
	Acroptilon repens	Poaceae		NI
	Agropyron elongatum	Poaceae	Tall wheatgrass	NI
	Agrostis stolonifera	Poaceae	Creeping bentgrass	FACW
	Beckmania sizigachne	Poaceae	American sloughgrass	OBL
*	*Bromus tectorum*	Poaceae	Cheatgrass	NI
*	*Bromus willenowii*	Poaceae	Rescue grass	NI
*	*Crypsis schoenoides*	Poaceae	Swamp timothy	FACW
	Distichlis spicata	Poaceae	Inland saltgrass	FAC+

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	Genus and species	**Family**	**Common Name**	**Wetland Status**
Grasses (cont.)				
*	*Echinochloa crusgalli*	Poaceae	Barnyard grass	FACW
	Elymus Cinereus			
	Elymus triticoides	Poaceae	Creeping wildrye	FAC+
	Eragrostis orcuttiana	Poaceae	Orcutt lovegrass	NI
*	*Eremopyrum triticeum*	Poaceae	Annual wheatgrass	NI
*	*Festuca pratensis*	Poaceae	Meadow fescue	FACU
	Hordeum brachyantherum	Poaceae	Meadow barley	FACW-
	Hordeum jubatum	Poaceae	Foxtail barley	FAC
	Leptochloa fascicularis	Poaceae	Bearded sprangletop	OBL
	Muhlenbergia asperifolia	Poaceae	Alkali muhly	FACW+
	Paspalum distichum	Poaceae	Knot grass	OBL
*	*Poa pratensis*	Poaceae	Kentucky bluegrass	FACU
*	*Polypogon monspeliensis*	Poaceae	Rabbitfoot grass	FACW+
*	*Puccinellia distans*	Poaceae	European alkali grass	OBL
	Puccinellia nuttalliana	Poaceae	Nuttall's alkali grass	OBL
*	*Setaria viridis*	Poaceae	Green bristlegrass	NI
	Sporobolus pulvinatus	Poaceae	Six-weeks dropseed	NI
Low Graminaceous				
	Carex anthrostachya	Cyperaceae	Slender-beak sedge	FAC
	Carex lanuginosa	Cyperaceae	Wooly sedge	OBL
	Carex vulpinoidea	Cyperaceae	Foxtail sedge	OBL
	Eleocharis palustris	Cyperaceae	Creeping spikerush	OBL
	Eleocharis parishii	Cyperaceae	Parish's spikerush	OBL
	Juncus articulatus	Juncaceae	Jointed rush	OBL
	Juncus balticus	Juncaceae	Baltic rush	FACW
	Juncus torreyi	Juncaceae	Torrey's rush	FACW+
	Triglochin concinna	Juncaginaceae	Seaside arrow grass	OBL
	Triglochin maritima	Juncaginaceae	Utah arrow grass	OBL
Emergents				
	Equisetum arvense	Equisetaceae	Common horsetail	FAC+
	Equisetum laevigatum	Equisetaceae	Smooth scouring rush	FACW
	Phragmites australis	Poaceae	Common reed	FACW+
	Scirpus acutus ssp. *occidentalis*	Cyperaceae	Hardstem bulrush	OBL
	Scirpus americanus	Cyperaceae	Olney threesquare	OBL
	Scirpus maritimus	Cyperaceae	Alkali bulrush	OBL
	Scirpus nevadensis	Cyperaceae	Nevada bulrush	OBL
	Scirpus pungens	Cyperaceae	Common threesquare	OBL
	Typha domingensis	Typhaceae	Southern cattail	OBL
	Typha latifolia	Typhaceae	Broad-leaf cattail	OBL

	Genus and species	Family	Common Name	Wetland Status
Forbs				
	Alisma gramineum	Alismataceae	Narrow leaf water plaintain	OBL
	Ambrosia acanthicarpa	Asteraceae		NI
	Artemisia douglasiana	Asteraceae	Douglas' wormweed	FAC
	Artemisia dracunculus	Asteraceae	Tarragon	NI
	Artemisia ludoviciana	Asteraceae	Silver wormwood	FACU
	Asclepias fascicularis	Asclepiadaceae	Narrow-leaf milkweed	FAC-
	Asclepias speciosa	Asclepiadaceae	Showy milkweed	FACW
	Asparagus acanthicarpa ssp. officianalis	Liliaceae	Garden asparagus-fern	FACU
	Aster frondosus	Asteraceae	Leafy aster	OBL
	Aster lanceolatus ssp. hesperius	Asteraceae	Western lined aster	OBL
	Astragalus spp.	Fabaceae	Milkvetch	NI
	Atriplex argentea	Chenopodiaceae	Silverscale saltbush	FAC
*	*Atriplex heterosperma*	Chenopodiaceae	Two scale orache	NI
	Atriplex patula	Chenopodiaceae	Spear saltbush	FACW
	Atriplex phyllostegia	Chenopodiaceae	Arrow saltbush	FACW
	Atriplex subspicata	Chenopodiaceae		NI
	Atriplex truncata	Chenopodiaceae	Wedgescale	FAC
*	*Bassia hyssopifolia*	Chenopodiaceae	Five-horn smother weed	FACW
	Berula erecta	Apiaceae	Cutleaf water parsnip	OBL
	Bidens frondosa	Asteraceae	Devil's beggar-ticks	FACW
	Camissonia claviformis ssp. integrior	Onagraceae	Clavate fruit primrose	NI
*	*Cardaria pubescens*	Brassicaceae	Whitetop	NI
	Castilleja exilis	Scrophulariaceae	Small flower indian paintbrush	OBL
	Castilleja minor ssp. minor	Scrophulariaceae		FAC
*	*Centaurea repens*	Asteraceae	Russian knapweed	NI
	Centaurium exaltatum	Gentianaceae	Great basin centaury	FACW
	Chamaesyce ocellata ssp. areicola	Euphorbiaceae	Valley spurge	FACW
*	*Chenopodium album*	Chenopodiaceae	Lamb's quarters	FACU
*	*Chenopodium foliosum*	Chenopodiaceae	Leafy goosefoot	NI
*	*Chenopodium glaucum ssp. salinum*	Chenopodiaceae	Oakleaf goosefoot	FACW
*	*Chenopodium rubrum var. rubrum*	Chenopodiaceae	Red goosefoot	OBL
	Chenopodium strictum var. glaucophyllum	Chenopodiaceae		NI
*	*Cichorium intybus*	Asteraceae	Common chickory	NI
	Circium mohavensis	Asteraceae	Mojave thistle	FACU
*	*Cirsium vulgare*	Asteraceae	Bull-thistle	FAC
	Cleome sparsifolium	Capparaceae	Few leaf cleome	NI
*	*Convolvulus arvensis*	Convulvulaceae	Field bindweed	NI
	Conyza canadensis	Asteraceae	Horseweed	FAC
	Cressa truxillensis	Convulvulaceae	Alkali weed	FACW
	Cryptantha circumcissa	Boraginaceae	Cushion cryptantha	NI
	Descurania pinnata	Brassicaceae	Tansy mustard	NI
	Epilobium ciliatum ssp. ciliatum	Onagraceae	Hairy willow herb	FAC

Forbs (cont.)

	Genus and species	**Family**	**Common Name**	**Wetland Status**
	Eriastrum sparsiflorum	Polemoniaceae	Great basin eriastrum	NI
	Eriogonum deflexum	Polygonaceae	Flat-topped buchwheat	NI
	Eriogonum maculatum	Polygonaceae	Spotted buckwheat	NI
*	*Erodium cicutarium*	Geraniaceae	Redstem filaree	NI
	Euthamia occidentalis	Asteraceae	Westrn fragrant goldenrod	OBL
	Galium trifidum var. pacificum	Rubiaceae	Small bedstraw	OBL
*	*Gnapthalium luteo-album*	Asteraceae	Weedy cudweed	FACW
	Grindelia squarrosa	Asteraceae	Curly-cup gumweed	FACU
*	*Halogeton glomeratus*	Chenopodiaceae	Halogeton	NI
	Helianthus annuus	Asteraceae	Common sunflower	FACU
	Heliotropium curassavicum	Boraginaceae	Seaside heliotrope	OBL
	Iva axillaris ssp. robustior	Asteraceae	Poverty weed	FACW
*	*Kochia scoparia*	Chenopodiaceae	Mexican summer-cress	FAC
*	*Lactuca serriola*	Asteraceae	Prickly lettuce	FACU
*	*Lepidium latifolium*	Brassicaceae	Broad-leaf peppergrass	FAC
*	*Lepidium perfoliatum*	Brassicaceae	Clasping peppergrass	FACU
	Lesquerella tennella	Brassicaceae	Bladderpod	NI
*	*Lotus tenuis*	Fabaceae	Slender birds-foot trefoil	NI
	Lupinus sp.	Fabaceae	Sand lupine	NI
	Lycopus asper	Lamiaceae	Western water-horehound	OBL
*	*Malva neglecta*	Malvaceae	Common mallow	NI
	Malvella leprosa	Malvaceae	Alkali mallow	FAC
	Malvella sp.	Malvaceae		NI
*	*Melilotus alba*	Fabaceae	Sweet clover	FACU
	Mentha arvensis	Lamiaceae	Field mint	FACW
	Mimulus guttatus	Scrophulariaceae	Yellow monkey-flower	OBL
	Mirabilis alipes	Nyctaginaceae	Four-o'clock	NI
*	*Nicotiana acuminata var. multiflora*	Solanaceae	Many flower tobacco	NI
	Oenothera elata ssp. hookeri	Onagraceae	Hooker,s evening primrose	FACW
	Opuntia pulchella	Cactaceae	Sand cholla	NI
	Plantago erecta	Plantaginaceae		
*	*Plantago lanceolata*	Plantaginaceae	English plaintain	FACU
*	*Plantago major*	Plantaginaceae	Common plaintain	FAC
*	*Polygonum arenastrum*	Polygonaceae	Common knotweed	NI
*	*Polygonum argyrocoleon*	Polygonaceae	Silver-sheath knotweed	FAC
	Polygonum aviculare	Polygonaceae	Prastrate knotweed	FACW
	Polygonum lapathifolium	Polygonaceae	Willow-weed	OBL
*	*Polygonum persicaria*	Polygonaceae	Lady's thumb	FACW
*	*Portulaca oleracea*	Portulacaceae	Common purslane	FAC
	Potentilla glandulosa	Rosaceae	Sticky cinquefoil	FACU
	Ranunculus aquatilus	Ranunculuaceae	White water buttercup	OBL
	Ranunculus cymbalaria var. saximontanus	Ranunculaceae	Desert buttercup	OBL
	Rorippa curvisiliqua	Brassicaceae	Curve-pod yellow cress	OBL
*	*Rumex crispus*	Polygonaceae	Curly dock	FACW
	Rumex maritimus	Polygonaceae	Golden dock	FACW
	Rumex salsifolius var. triangulivalvis	Polygonaceae	Triangular valve dock	FACW
	Sagittaria cuneata	Alismataceae	Narrow leaf water plaintain	OBL

Genus and species	Family	Common Name	Wetland Status
Forbs (cont.)			
* *Salicornia europaea*	Chenopodiaceae	Slender glasswort	OBL
* *Salsola tragus*	Chenopodiaceae	Russian thistle	FACU
Sesuvium verrucosum	Aizoaceae	Western sea-purslane	FACW+
* *Solanum dulcamara*	Solanaceae	Climbing nightshade	FAC
Solidago spectabilis	Asteraceae	Basin goldenrod	FACW
* *Sonchus asper*	Asteraceae	Prickly sow-thistle	FACU
* *Spergularia marina*	Caryophyllaceae	Saltmarsh sandspurry	OBL
Sphaeralcea ambigua	Malvaceae	Desert mallow	NI
Sphaerophysa ambigua	Fabaceae		NI
* *Sphaerophysa salsula*	Fabaceae	Alkali swainsonpea	FAC
Stephanomeria exigua ssp. *exigua*	Asteraceae	Skeleton-weed	NI
Suaeda calceoliformis	Chenopodiaceae	Pursh seablite	FACW
* *Taraxacum officinale*	Asteraceae	Common dandelion	FACU+
* *Tragopogon dubius*	Asteraceae	Goatsbeard	NI
* *Trifolium fragiferum*	Fabaceae	Strawberry clover	FACW-
Trifolium variegatum	Fabaceae	White-tip clover	FACW-
Urtica dioca	Urticaceae	Stinging nettle	FAC
* *Veronica anagallis-aquatica*	Scrophulariaceae	Water sppedwell	OBL
Veronica peregrina	Scrophulariaceae	Purslane speedwell	FACW+
Xanthium strumarium	Asteraceae	Common cocklebur	FAC
Aquatics			
Azolla mexicana	Salviniaceae	Mosquito-Fern	OBL
Bacopa eisenii	Scrophulariaceae	Water hyssop	OBL
Callitriche hermaphroditica	Callitrichaceae	Autumnal water starwort	OBL
Ceratophyllum sp.	Ceratophylaceae	Coontail	OBL
Lemna minor	Lemnacea	Duckweed	OBL
Marsilea vestita ssp. *vestita*	Marsiliaceae	Water-Clover	OBL
Najas guadalupensis	Najadaceae	Water nymph	OBL
Potamogeton crispus	Potamogetaceae	Curly pondweed	OBL
Potamogeton filiformis var. *latifolius*	Potamogetaceae	Nevada pondweed	OBL
Potamogeton nodosus	Potamogetaceae	Long-leaved pondweed	OBL
Potamogeton pectinatus	Potamogetaceae	Sago pondweed	OBL
Ricciocarpus natans			
Ruppia maritima	Ruppiaceae	Widgeon grass	OBL
Zannichellia palustsris	Zannichelliaceae	Horned pondweed	OBL
Agricultural Species			
* *Medicago sativa*	Fabaceae	Alfalfa	NI
* *Zea mays*	Poaceae	Corn	NI

1. Wetland indicator status is taken from Reed (1988).

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APPENDIX C:
Species Lists for Anaho Island NWR

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ANIMAL SPECIES LIST
OF
ANAHO ISLAND

Common name	***Genus species***
Bird	
common loon	*Gavia immer*
Pacific loon	*Gavia pacifica*
Clark's grebe	*Aechmophorus clarkii*
western grebe	*Aechmophorus occidentalis*
horned grebe	*Podiceps auritus*
eared grebe	*Podiceps nigricollis*
American white pelican	*Pelecanus erythrorhyncos*
double-crested cormorant	*Phalacrocorax auritus*
great blue heron	*Ardea herodias*
snowy egret	*Egretta thula*
black-crowned night heron	*Butorides striatus*
Canada goose	*Branta canadensis*
mallard	*Anas platyrhynchos*
gadwall	*Anas strepera*
American wigeon	*Anas americana*
northern pintail	*Anas acuta*
ruddy duck	*Oxyura jamaicensis*
redhead	*Aythya americana*
greater scaup	*Aythya marila*
lesser scaup	*Aythya affinis*
common goldeneye	*Bucephala clangula*
bufflehead	*Bucephala albeola*
common merganser	*Mergus merganser*
American coot	*Fulica americana*
killdeer	*Charadrius vociferous*
black-necked stilt	*Himantopus mexicanus*
marbled godwit	*Limosa fedoa*
spotted sandpiper	*Actitis macularia*
Wilson's phalarope	*Phalaropus tricolor*
red-necked phalarope	*Phalaropus lobatus*
ring-billed gull	*Larus delawarensis*
herring gull	*Larus argentatus*
California gull	*Larus californicus*
Caspian tern	*Sterna caspia*
turkey vulture	*Cathartes aura*
red-tailed hawk	*Buteo jamaicensis*
bald eagle	*Haliaeetus leucocephalus*
northern harrier	*Circus cyaneus*
prairie falcon	*Falco mexicanus*
American kestrel	*Falco sparverius*
Mourning dove	*Zenaida macroura*
Barn owl	*Tyto alba*
Rufous hummingbird	*Selasphorus rufus*
Say's phoebe	*Sayornis saya*
Western kingbird	*Tyrannus verticalis*
Barn swallow	*Hirundo rustica*
Violet-green swallow	*Tachycineta thalassina*
Common raven	*Corvus corax*
Canyon wren	*Catherpes mexicanus*

Rock wren	*Salpinctes obsoletus*
Mountain bluebird	*Sialia currucoides*
Loggerhead shrike	*Lanius ludovicianus*
Yellow-rumped warbler	*Dendroica coronata*
Black-throated sparrow	*Amphispiza bilineata*
Dark-eyed junco	*Junco hyemalis*
Song sparrow	*Melospiza melodia*
Savannah sparrow	*Passerculus sandwichensis*
Brewer's sparrow	*Spizella breweri*
White-crowned sparrow	*Zonotrichia leucophrys*
Brewer's blackbird	*Euphagus cyanocephalus*
Brown-headed cowbird	*Molothrus ater*
Western meadowlark	*Sturnella neglecta*
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*
House finch	*Carpodacus mexicanus*

Mammal

deer mouse	*Peromyscus maniculatus*

Amphibians and Reptiles

western whiptail	*Cnemidophorus tigris tigris*
Zebra-tailed lizard	*Callissurus dracoides myurus*
desert spiny lizard	*Sceloporus magister*
side-blotched lizard	*Uta stansburiana stansburiana*
desert horned lizard	*Phrynosoma platyrhinos platyrhinos* *
Great Basin rattlesnake	*Crotalus viridis lutosus*
gopher snake	*Pituophis catenifer*
desert striped whipsnake	*Masticophis taeniatus*
western garter snake	*Thamnophis elegans*

Invertebrates

grasshoppers	Family Locustidae
solitary darkling beetles	Family Tenebrionidae
tiger beetles	Family Cicindelidae
carrion beetles	Family Silphidae
hister beetles	Family Histeridae
flies	Family Ephydridae
biting bird lice	*Tetrophthalmus* sp.
parasite	Family Cimicidae
black widow spider	*Latrodectus muctana*
orb-weaving spider	*Neoscona oaxacensis*

CHARACTERISTIC PLANT SPECIES
OF
ANAHO ISLAND

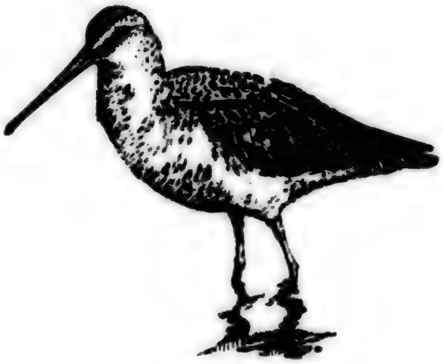
Common name	*Genus species*
UPLAND	
Shrubs	
dudsage	*Artemesia spinescens*
mountain big sagebrush	*Artemesia tridentata tridentata*
fourwing saltbush	*Atriplex canescens*
shadscale	*Atriplex confertifolia*
littleleaf brickellbush	*Brickellia microphylla*
rubber rabbitbrush	*Chrysothamnus nauseousus albicaulis*
green rabbitbrush	*Chrysothamnus viscidiflorus*
winterfat	*Eurotia lanata*
spiny hopsage	*Grayia spinosa*
salt heliotrope	*Heliotropium curassavicum*
Bigelow's four o'clock	*Mirabilis bigelovii var. retrorsa*
big greasewood	*Sarcobatus vermiculatus*
thorn skeletonweed	*Stephanomeria spinosa*
littleleaf horsebrush	*Tetradymia glabrata*
Forbs	
mat amaranth	*Amaranthus blitoides*
fiddleneck	*Amsinckia tesselata*
specklepod milkvetch	*Astragalus lentiginosus*
Utah milkvetch	*Astragalus utahensis*
fivehook bassia	*Bassia hyssopifolia*
fleshcolor pincushion	*Chaenactis xantiana*
Watson's catseye	*Cryptantha watsonii*
western tansymustard	*Descurainia pinnata*
flatcrown buckwheat	*Eriogonum deflexum*
birdnest buckwheat	*Eriogonum nidularium*
redstem stork's bill	*Erodium cicutarium*
small thymeleaf sandmat	*Euphorbia serypllifolia*
prickly lettuce	*Lactuca serriola*
desert pepperweed	*Lepidium fremontii*
smooth desertdandelion	*Malacothrix glabrata*
white-stemmed stick leaf	*Mentzelia albicaulis*
smoothstem blazingstar	*Mentzelia laevicaulis*
Booth's suncup	*Oenothera boothii*
browneyes	*Oenothera claviformis*
Brown's peony	*Paeonia brownii*
cleftleaf wildheliotrope	*Phacelia crenulata*
annual psathyrotes	Psathyrotes annua
Russian thistle	*Salsola kali var. tenuifolia*
tall tumblemustard	*Sisymbrium altissimum*
Grasses	
ripgut brome	*Bromus rigidus*
red brome	*Bromus rubens*

cheatgrass	*Bromus tectorum glabrata*
desert saltgrass	*Distichlis stricta*
foxtail barley	*Hordeum jubatum*
hare barley	*Hordeum leporinum*
mouse barley	*Hordeum murinum*
squirrel tail	*Sitanion hystrix*
desert needlegrass	*Stipa speciosa*

Lichens and Moss

bluish-white lichen	*Buellia albo*
deep-orange *lichen*	*Caloplaca cinnabarinum*
yellow-green lichen	*Caloplaca elegans*
orange lichen	*Calopleca murerum*
moss	*Encalypta vulgaris*
pale-green lichen	*Lacanora caxiola*
moss	*Tortula ruralis*
black lichen	*Verrucaria luscella*
bright orange lichen	*Xanthoria candelaria*

APPENDIX D: Biological Monitoring Program



Long-billed Dowitcher
by Larry Eifert

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APPENDIX D

Stillwater NWR Complex Biological Monitoring Program Summary

Preface

This appendix is intended to be a discussion of the general direction monitoring will proceed under Alternative C of the draft Stillwater NWR CCP and boundary Revision EIS. The final version will contain protocol for each monitoring effort, field sheets, data storage requirements, analyses to be conducted, and linkage among created databases to address implementation of habitat management strategies outlined in the refuge CCP. Therefore, this appendix is meant to inspire discussion relative to refuge monitoring needs, whether the design of this plan is adequate to measure implementation success, and if we are asking (and monitoring) the right questions to address adaptive management during the 15-year life of the Stillwater NWR CCP..

Introduction

Past monitoring efforts on National Wildlife Refuges have generally focused on key species and habitats; typically those considered sensitive (e.g., endangered species) or those species identified in refuge establishing authorities (e.g., waterfowl, shorebirds), or otherwise deemed important. While these programs were adequate to identify trends in these higher priority species, more often than not, they failed to examine the refuge landscape holistically, and this did not identify all components common to the refuge environment. This is not to say that we should choose to study each organism at a high level of detail, as this would require many decades with a small army of biologists and/or outdoor recreation planners. Instead, we should carefully select the components we choose to monitor, ensuring that each component is representative of many other species/habitats (considered an indicator species) or that the component would not be represented through the indicator approach. Additionally, we should ask the right monitoring questions to ensure that we ultimately have the ability to critically analyze collected data, the means to measure our success at implementing refuge Comprehensive Conservation Plans (CCP), and that we have the flexibility to adapt as information directs us to alter existing management and monitoring approaches.

Under Alternative C of the Stillwater NWR CCP-EIS, we have been guided to examine the extent and restorability of natural functions and processes, with management emphasis on restoring and maintaining natural biological diversity. Additional, but equally important purposes include fulfilling international treaty obligations and providing opportunities for scientific research, environmental education, and fish and wildlife oriented recreation. These purposes were outlined under Public Law 101-618 Sec.206(4)(b)(2) and require specific monitoring protocol to ensure that we are fulfilling their intent.

Based on these purposes, three primary goals were established for Stillwater NWR under Alternative C including:

Goal A: Conserve and manage fish, wildlife, and their habitat to restore and maintain natural biological diversity. (4 subgoals)

Goal B: Contribute toward fulfilling obligations of international treaties and other international agreements with respect to fish and wildlife. (3 subgoals)

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Goal C: Provide opportunities for environmental education and wildlife-dependent recreation that are compatible with refuge purposes and the Refuge System mission. (4 subgoals)

Along with two additional goals established for Anaho Island NWR:

Goal A: Protect and perpetuate colonial-nesting birds and other migratory birds.

Goal B: Restore and maintain natural biological diversity.

Under each goal and subgoal, a series of objectives were developed which identify parameters used to measure our relative success in fulfilling purposes established under public law 101-618 as outlined in Alternative C of the Stillwater NWR CCP-EIS. There are 49 draft objectives for Stillwater NWR related to wildlife and habitat (38 and 12 each for goals A and B), 25 are directly related to habitat, seven to wildlife, and 17 which are a combination of wildlife, habitat, and people management. Ultimately, all objectives relate back to wildlife; however, the emphasis on habitat follows the proposed management philosophy under Alternative C which is to restore and/or mimic natural habitat conditions.

U.S. Fish and Wildlife Service Policy

U.S. Fish and Wildlife Service monitoring and inventory plan policy (701 FW 2), indicates that four types of surveys are appropriate for station level monitoring plans. These range from Type I to Type IV surveys with definitions for each as follows:

Type I: Species Lists - All species known to occur on the refuge unit including plants, invertebrates, and vertebrate species groups. These lists should be updated annually with strategies developed to fill identified information gaps.

Type II: Qualitative Surveys - These are surveys where observational data only are obtained. In some instances, it is difficult to obtain data where trend or statistical analyses are difficult to perform (e.g., observation of rare or unusual species). These data should still be acquired and stored in programs such as AVISYS as they are useful for updating species lists as new species are documented.

Type III: Quantitative Surveys - These surveys are the backbone of a biological monitoring plan and provide the data necessary to examine long-term trends useful for adaptive management strategy development. These surveys must be carefully designed with rigorous statistical analyses developed to interpret the data. They can include monitoring efforts completed by refuge personnel, graduate students, or other outside research concerns, and should be of publication quality upon completion.

Type IV: Special Cooperative Surveys - these surveys include data sets collected on a refuge unit which are part of larger state, ecoregion, and national data collection efforts. Examples appropriate to Stillwater NWR complex include, breeding bird surveys, shorebird surveys, Christmas bird counts, bird banding efforts, and contaminants monitoring conducted in conjunction with a variety of local, state, private, and other Federal organizations.

The vast majority of monitoring procedures described in this Inventory and Monitoring Plan will produce Type I or III data sets with minimal emphasis placed on Type II efforts. Preexisting Type IV cooperative efforts will be continued as they lead to an understanding of wildlife populations on a landscape scale with direct applicability to populations occurring on Stillwater NWR.

General Strategies to Implement Program

Monitoring strategies can broadly be described under six program areas including literature search and baseline inventory, water monitoring, habitat monitoring, wildlife censuses, outside research, and comparisons with objectives monitored under the public use monitoring program (Table 1). The preceding list follows a hierarchical approach based on our current needs and our level of understanding of natural conditions surrounding each parameter. For example, our primary current need is literature searches and baseline inventory information on parameters selected for observation under Alternative C. Many of the target groups have not been monitored in the past, but are integral to ensuring we are monitoring as much of the system as is reasonably possible. This will be the first level of monitoring needs within this plan.

Following these initial inventories, water, habitat, and wildlife monitoring strategies are ordered based on our understanding of each individual component. This roughly equates to a knowledge continuum where our best existing data and understanding of natural function is related to water movement, followed by habitat, and then by wildlife populations. Few data are available to estimate what historic or natural population levels were for most wildlife species on Stillwater NWR; however, through simulation of natural hydrological characteristics, it is assumed that native plant communities will form, providing habitat for the natural complement of wildlife species which are associated with the natural system. It is understood that historic hydrologic function cannot be restored on Stillwater NWR, but monitoring should provide the data to determine whether we are moving towards this desired goal. The following sections will provide a discussion of the basic elements involved in each of the different monitoring areas. Completion of all biological monitoring objectives are based on the following minimum staffing requirements identified in the Stillwater NWR CCP-EIS.

GS-11	PFT	Wildlife Biologist
GS-9/11	PFT	Wildlife Biologist
GS-7/9	PFT	Wildlife Biologist
GS-5	TPT	Biological Technician (6 month's)
2-4	Volunteers/3 months	

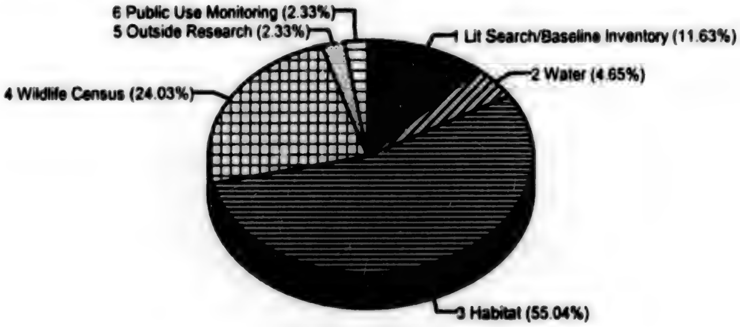
Literature Search and Baseline Inventories

Over the past several years, efforts have been made to collect baseline information on a variety of communities inhabiting Stillwater NWR including aquatic and terrestrial invertebrates; upland, wetland, and riparian vegetation; bats; butterflies; small mammals; leopard frogs; snowy plover; fish; saltcedar; as well as a variety of other species. Many of these inventories were comprehensive and provided much of the information used in developing the refuges comprehensive conservation plan. While these exercises have been valuable, it is understood that they only represent one point in time and some inventories, failed to locate and/or generate population estimates for target species/communities that accurately reflect their natural representation at the refuge.

Early phases of monitoring plan implementation will consider species or species groups where we have little to no baseline information available and utilize volunteer and/or outside research organizations to initiate data collection. Monitoring targets including aquatic mammals, predators (mammalian and avian), amphibians, reptiles, and plants will have baseline inventories and literature searches conducted as soon as individuals are identified to complete the project; however, additional scoping will be conducted by Stillwater NWR biological staff to identify other baseline requirements to implement this monitoring plan.

Table 1: Broad program areas under which monitoring protocol will be developed and number of objective monitoring requirements satisfied by each technique.

Program Area	USFWS Monitoring Protocol Used	Number of Objectives Monitored
Literature Search/Baseline Inventory	Types I and II	15
Water Monitoring	Type III	6
Habitat Monitoring	Type III	41
Wildlife Census	Types III and IV	26
Outside Research	Type III	3



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Water Monitoring

Water distribution is the primary management tool used at Stillwater NWR to meet the goals outlined in the refuges draft CCP-EIS. Timing, amount, duration, and location of inflow are key elements to achieving wetland acreage and habitat targets, and monitoring procedures must be designed to ensure we are in compliance with the stated objectives. Additionally, contaminant concerns have been identified in many of the refuge wetlands, riparian areas, and delivery canals which could lead to potential effects to breeding species using refuge habitats. Therefore, a combination of flow monitoring, measurement of overall wetland acreage provided in different seasons, and contaminants monitoring will be the primary facets involved in the water monitoring component of the refuges biological monitoring plan.

Water flow monitoring will be conducted weekly. Flow rate, measured in cubic feet/second (cfs), will be measured at all refuge input points and all refuge water control structures. Each month, total dissolved solids (TDS), pH, and total dissolved oxygen will be measured to index quality of the water entering refuge habitats. Additional efforts to characterize contaminant relationships with water quality will be conducted by the contaminants branch of the FWS with periodic studies conducted to identify contaminant levels in various biological communities. Through remote sensing analysis, this information will be compared to seasonal wetland acreage with flow characteristics compared to wetland acres produced. Contaminant concern wetland units or areas will be mapped to identify long-term trends in contaminant concentrations relative to water management strategies. This information will ultimately be used to predict vegetation response to water management to help fulfill habitat objectives identified in the following section.

Habitat Monitoring

Considering that a wide variety of upland, riparian, and wetland habitats are juxtaposed throughout a 170,000 acre NWR, intensive field sampling is not an appropriate method to monitor annual changes in habitat. Instead, a combination of remote sensing; permanent and random quadrats; line transecting, and cruising will be used. Remote sensing (aerial imagery analysis) will form the backbone of the habitat monitoring program with analysis intensity directly related to anticipated changes in vegetation communities. For example, wetland habitats are expected to fluctuate widely, therefore, biannual analysis occurring in spring and early fall will be completed. Conversely, upland habitats are not expected to change as dramatically and subtle changes (e.g., grass communities in the shrub understory) would likely not be detected. For these habitats, aerial imagery analysis would be completed every five years with a combination of quadrat sampling, line transecting, and cruising used to interpret subtle changes in understory vegetation. Strategies to implement quadrat and line transect methodologies for all Stillwater NWR habitat types are offered in Table 2. Cruising will be used to monitor distribution and abundance of invasive species as well as to document presence of rare species, or species of limited distribution.

Wildlife Monitoring

While water management and the habitats produced are a primary focus of the biological monitoring program, it is equally important to document the fish and wildlife populations utilizing these habitats. A variety of census, survey, and wildlife marking procedures will be used to perform 26 separate wildlife census, survey, and marking efforts annually (four are currently conducted by outside organizations but may be incorporated as staff responsibility in future years). Monitoring efforts will focus on a proportional combination of avian, mammalian, amphibian, fish, reptile, invertebrate, rare species, and baseline population inventories requiring an estimated 186 - 245 total staff days to complete which should be easily fulfilled by the minimum biological staffing requirements outlined earlier in this discussion. Rather than describe each individual wildlife monitoring approach, Appendix 1 offers the target guilds/species to be monitored, the general techniques to be used, the timing and intensity of survey implementation, the staff days required, and the party responsible for data collection.

Table 2: Sampling methodology and intensity used to monitor Stillwater NWR wetland, upland, and riparian habitats defined in the Stillwater NWR CCP-EIS.

Wetland	**Deep, Open Water**	Quantified through aerial imagery analysis
	Submergent	Line transects previously established in all refuge units (13 units).
	Deep Emergent	Extension of submergent line transects and random placement of 10 quadrats to verify species composition
	Shallow Emergent	Extension of submergent line transects and random placement of 10 quadrats to verify species composition
	Moist-Soil	Random placement of 20 quadrats to verify species composition
	Wet Meadow	Random placement of 20 quadrats to verify species composition and continuation of 20 quadrats at Fallon NWR grazing study site
	Wetland Shrub	Random placement of 10 quadrats to verify species composition
	Unvegetated Alkali Mudflat	Quantified through aerial imagery analysis
	Playa	Quantified through aerial imagery analysis
Riparian	**Riverine Channel and Tree Communities**	Establishment of 20 permanent 100 m cross-sectional transects sampled at 10 m intervals and random placement of 10 quadrats to verify species composition
	Seasonal Overflow	Random placement of 10 quadrats to verify species composition
	Riverine Delta	Random placement of 10 quadrats to verify species composition
Upland	**Greasewood Shrubland**	Establishment of 5 permanent 1000 m transects sampled at 10 m intervals
	Saltbush Desert Shrubland	Establishment of 5 permanent 1000 m transects sampled at 10 m intervals
Sand Dunes	**Sand Dunes**	Establishment of 5 permanent 1000 m transects sampled at 10 m intervals

Outside Research

While a comprehensive inventory of refuge resources will be completed through implementation of the procedures described in the biological monitoring plan, there are some areas that require more intensive effort and/or specialized expertise. For example, contaminant monitoring falls outside the scope of what Stillwater NWR biological staff can reasonably and efficiently accomplish. Therefore, contaminant sampling will be administered by FWS contaminants personnel with analyses to be contracted out to an independent laboratory. Cooperative agreements have been developed in the past with the University of Nevada-Reno, to assess upland vegetation and faunal community distribution. A graduate student from

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Louisiana State University collected intensive life history information on white-faced ibis. In the future, research questions addressing interactions among wildlife and the visiting public, Indian ricegrass and kangaroo rats, and the relationships between deep emergent vegetation stands and overwater nesting birds should be answered. These questions, as well as other complex research questions anticipated to arise are best suited to cooperative efforts, typically lead by outside research organizations. Priority will be given to projects specifically addressing Stillwater NWR research needs; however, proposals submitted for other research purposes will be encouraged and reviewed for implementation on a case by case basis.

Anaho Island NWR

While evaluating monitoring needs for Anaho Island NWR, six objectives combined between protecting colonial nesting species and restoring and maintaining natural biological diversity were identified. From these objectives, eight preliminary monitoring strategies were developed (Appendix 2). These eight procedures can be fulfilled through a combination of remote sensing, ground census, line transecting, baseline inventory techniques, and by cooperation between refuge staff and outside research entities. Results from baseline inventory/outside research efforts will be used to identify additional biological monitoring needs and to refine monitoring protocol as thc data indicate. Long-term data sets collected by outside research concerns should be obtained and compared with Anaho Island biological monitoring data. Approximately 38-49 staff days distributed among the GS-11 Anaho Island NWR manager and Stillwater NWR complex biological staff, will be required to complete this plan. The addition of an Anaho Island wildlife biologist would allow for increasing effort in future years.

Other Monitoring Efforts and Summary

In addition to the biological monitoring program, a Stillwater NWR Public Use Monitoring Plan will be developed. The data collected under this program can be compared with biological monitoring components to assess interactions between these broad program areas. All components from each program will be entered and stored within a developing, relational database manager which will allow for data analyses within and among monitoring efforts. These analyses can then be used to develop adaptive management strategies for future years and are intended to be incorporated in annual step-down management plans for water, habitat, and public use. The efforts described in this biological monitoring program summary should provide the data required to perform the necessary analyses; however, as the database manager develops, flexibility will be left into the plan to adapt monitoring strategies as shortfalls are identified or more refined protocol are developed.

In summary, 49 objectives related to habitat and wildlife were developed from 3 goals for Stillwater NWR and 2 for Anaho Island NWR under Alternative C of the Stillwater NWR CCP-EIS. Monitoring protocol to measure our relative success at fulfilling these objectives were divided among five areas including literature search/baseline inventory, water monitoring, habitat monitoring, wildlife censuses, and outside research. A series of techniques will be developed within each of these categories which are consistent with USFWS monitoring policy (701 FW 2) and will encompass a combination of Type I through Type IV survey protocol. Primary emphasis will be on monitoring habitat objectives; however, within each category, a more equal focus on the variety of habitats and wildlife species inhabiting Stillwater and Anaho Island NWR's will be accomplished. Data collected from these monitoring efforts will be recorded and stored in a relational database manager, with analyses used to develop adaptive management strategies for water, habitat, and public use management. This summary does not provide much detail on the protocol to be used within the plan; however, Appendix 3 provides the list of objectives, the broad approach to be used, the target species/guilds to be monitored, and a condensed description of the monitoring procedures to be used.

Appendix 1: Past wildlife monitoring efforts, sampling period, intensity, staff days required, and additions/reductions to biological monitoring program.

Target Species/Guild	Broad Technique	Time of Year	Sampling Intensity	Staff Days Required	Organization	Adjustment
Avian Species/Guilds				35 - 46 staff days		
Waterfowl Population Inventory	Aerial Census	August - April	Monthly	None	NDOW	None
Waterfowl Breeding Pair Survey	Aerial Census	May	Single Count	None	NDOW	None
Waterfowl Brood Survey	Vehicle Census	May - August	Opportunistically w/coordinated late summer count	3-8	Refuge	Increase to index nesting success
Waterbird Banding	Trapping/Airboat	July - September	Opportunistically during summer	5-8 nights	Refuge	None - possible reduction
Goose Neck Collar Observation	Vehicle Census	October - January	Opportunistically	2-3 days	Refuge	Targeted reduction
Swan Census	Vehicle Census	October - March	Monthly	4-7 staff days	Refuge	Targeted reduction
Waterfowl Nest Searches	Nest Searches	April - July	Opportunistically	5-10 staff days	Refuge	Eliminated
Colonial Nesting Waterbird Breeding Pair Survey	Aerial Census	June	Single Count	None	NDOW	None
Shorebird Fall/Spring Population Inventory	Airboat/Ground	April, August	Two Counts	3-4 staff days	Refuge/NDOW	None
Snowy Plover Survey	Ground Survey	July	Single Count	2 staff days	Refuge	Addition
Mourning Dove Call Count	Ground/Call Count	June	Single Count	1 staff day	NDOW/Refuge	Eliminated
Bald Eagle Count	Ground/Roost Survey	October - March	Monthly	3-6 staff days	Refuge	Increased
Raptor Survey	Ground Count	Jan, Apr, Jul, Oct	Quarterly	4 staff days	Refuge	Increased
Avian Predator Survey (Raven)	Ground Count	April - June	Monthly	3 staff days	Refuge	Addition
Neotropical Migrants	Mist Netting	August - September	Daily	None	Partners in Flight Cooperators	None
Waterbird Migration Chronology	Ground Count	January - December	Bi monthly	48 staff days	Refuge	Addition
Disease Monitoring	Airboat Patrol	July - Sept, Dec - Apr	Opportunistically	16 - 48 staff days	Refuge	None

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Species/Guild	Broad Technique	Time of Year	Sampling Intensity	Staff Days Required	Organization	Adjustment
Mammal Species/Guilds						
Coyote/Predator Survey	Trail indicator	May - July	Monthly	3 staff days	Refuge	Addition
Small Mammal Survey	Live Trapping	June - August	monthly (3 days)	5 - 9 staff days	Refuge	Addition
Muskrat Survey	Aerial/Ground Census	Jan, Apr, Jul, Oct	Quarterly	4 staff days	Refuge	Addition
Bat Species Survey	Mist Net/Observation	June	Single Count	2 staff days	Refuge	Addition
Amphibian Species/Guilds						
Leopard frog/Bullfrog Surveys	Call Count	April - June	Monthly	3 staff days	Refuge	Addition
Spadefoot Toad Survey	Sweep Net Samples	April - June	Opportunistically	1 staff day	Refuge	Addition
Fish Species/Guilds						
Tui Chub/Mosquitofish Index	Minnow Trap	May, August	Monthly	2 - 4 staff days	Refuge	Addition
Carp/Gamefish Index	Electroshock	May, August	Monthly	2 - 4 staff days	Refuge/NDOW	Addition
Reptile Species/Guilds						
Lizard/Snake Population Index	Pitfall Trapping	June - August	Monthly	4 - 9 staff days	Refuge	Addition
Invertebrate Species/Guilds						
Terrestrial Invertebrates	Pitfall Trapping	June - August	Monthly	With above	Refuge	Addition
Water Column Invertebrates	Sweep Net Samples	May, August	Two Samples	5-10 staff days	Refuge	Addition
Benthic Invertebrates	Benthic Core Samples	May, August	Two Samples	With Above	Refuge	Addition
Rare Species Inventory						
Nevada Viceroy/Other Butterflies	Sweep Net Samples	June, July	Two Samples	2-4 staff days	Refuge	Addition
Other Baseline Inventories						
2 Conducted Annually	Various Techniques	June - August	Variable	60 volunteer days	Refuge	Addition

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Appendix 2: Minimum monitoring requirements for the Anaho Island Biological Monitoring Plan.

Monitoring Parameter	Broad Technique	Time of Year	Sampling Intensity	Staff Days Required	Organization
Biannually map Anaho island to document changes in island size, vegetation distribution, and colony location.	Aerial Photographs	May 1 and August 15	2 photo sessions	None	Outside Contractor will provide aerial photos
Document vegetation distribution relative to exotic species encroachment and native species restoration.	Vegetation Transects	March 1 and October 15	2 sampling sessions	2-4	Refuge
Colonial nesting waterbird counts	Ground Census, Photographs	March 15 -Sept 15	Bimonthly (13 counts)	26 staff days	Refuge
American white pelican banding	up to 400 juveniles annually	Mid June - Late July	2 banding periods	10 staff days	Refuge/Cooperators
Small Mammal Surveys	Live Trapping	March 1 and October 15 coordinated with vegetation sampling	2 sampling sessions	2-4	Refuge
Neotropical Migrant Surveys	Point intercept	March 1 and October 15 coordinated with vegetation sampling	2 sampling sessions	2-4	Refuge
Seasonal Wildlife Distribution	Cruising	Between October 15 and March 15	3 sampling sessions	3 staff days	Refuge
Baseline Inventory and Outside Research	Various techniques	Year Around	As Needed	5-10 staff days	Refuge/Outside Cooperators
TOTAL				**50-61 staff days**	

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Appendix 3: Goals, subgoals, and objectives outlined in the Stillwater NWR CCP-EIS; and the broad approach, resources monitored, and monitoring procedures used to measure our success at achieving objectives.

Goal	**Broad Approach**	**Resources Monitored**	**Monitoring Procedures**
Goal A: Conserve and manage fish, wildlife, and their habitat to restore and maintain natural biological diversity			
Subgoal A.a: Approximate a natural diversity within and among animal communities on Stillwater NWR	Estimate historic population levels, determine baseline population levels, and identify indicator species to monitor for each objective.		
Objective A.a.1 Restore and perpetuate the presence of all native species and native guilds of birds, mammals, reptiles, amphibians, fish, and invertebrates according to season.	Literature Search Indicator Species Baseline Inventory	Waterbirds, Upland birds, mammals, herps, invertebrates (T and A)	Following literature search, perform baseline inventories on species lacking information, continue protocol developed for these species.
Objective A.a.2: Restore and perpetuate population levels (or, use level of refuge) by each species to relative-abundances that would exist under natural conditions, recognizing natural fluctuations in populations	Literature Search Indicator Species	Waterbirds, Upland birds, mammals, herps, invertebrates (T and A)	Perform baseline inventories on species lacking information, continue protocol developed for these species.
Objective A.a.3: Minimize distribution and abundance of nonnative animal species and their prominence in fish and wildlife communities.	Nonnative Indicator Species	Carp, mosquitofish, game fish, bullfrogs, beaver	Annual fish surveys to assess relative ratios of native/non-native species. Annual amphibian surveys to assess the leopard frog/bullfrog ratio. Cruise riparian areas to estimate beaver abundance.
Subgoal A.b: Approximate, within a natural range of variability, a natural diversity within and between plant communities and habitat types	Estimate historic abundance and distribution, determine baseline abundance and distribution, and biannually map distribution of habitat types		
Objective A.b.1: Restore and perpetuate the presence of all native plant species and native plant communities in Stillwater Marsh, Battleground Marsh, Carson river corridor, Stillwater slough corridor, dune complex, and salt-desert shrub uplands	Rare Plant Inventory Remote Sensing	Wetland, Upland Shrub, Riparian, Sand Dune	Develop and initiate rare plant inventory for sand dune habitats, remap upland and riparian habitats every 5 years, biannually map and ground truth wetland habitats.
Objective A.b.2: Approximate and perpetuate the presence of all native plant species that would occur on Stillwater NWR under natural conditions - within a natural range of variability - including representation by all native plant communities and habitat types, amount of area occupied by each plant community and habitat type, and the distribution and pattern (shape) of each.	Literature Search and existing literature Quadrats Remote Sensing	Wetland, Upland Shrub, Riparian, Sand Dune	Use existing literature on upland, wetland and riparian habitats as a baseline, revisit selected plots annually to monitor changes within communities. Establish permanent plots in sand dune and riparian habitats.
Objective A.b.2(a): Attain and sustain a long-term average of 14,000 acres of wetland habitat on Stillwater NWR, including marsh, shallow lake, and riverine wetland habitat.	Remote Sensing	Wetland and riparian habitats	Biannually photograph and map distribution of wetland habitats in spring and fall.

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Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Objective A.b.2(b)(i):Attain and sustain a long-term average of 13,500 acres of wetland habitat in Stillwater Marsh in a way that attains the following seasonal targets: - 75-100% of peak acreage April-June (peak in late March/early April) - 40-70% of peak acreage July-September (>50% in July) - 55-70% of peak October-February	Remote Sensing Ground Estimates	Wetland and Riparian habitats	Use biannual wetland maps to estimate spring/fall habitat acreage, obtain monthly acreage estimates on all wetland units in conjunction with water distribution data.
Objective A.b.2(b)(ii): Approximate the natural mix of wetland habitat types and plant communities in Stillwater Marsh.	Literature Search Remote Sensing Line Transect Quadrats	Wetland, Riparian	Use biannual wetland/riparian photos to estimate extent of native habitat types, annually monitor established quadrats to document within community changes. Continue wetland line transects to estimate across wetland community distribution.
Objective A.b.2(b)(iii): Within 5 years, examine the feasibility and, if appropriate, develop a plan to restore native wet-meadow habitat in the area of the Kent and Weishaupt properties.	Management Plan Baseline Inventory Quadrats	Wet Meadow Habitats	Complete baseline inventory of plant species common to potential restoration areas. Establish permanent quadrats to track vegetation changes.
Objective A.b.2(c)(i): Attain a long-term average of 50-100 acres of riverine-wetland habitat on Stillwater NWR.	Remote Sensing	Riverine/Riparian Habitats	Use biannual wetland habitat maps to assess spring/fall riparian habitat acreages.
Objective A.b.2(c)(ii): Restore cottonwood, mesic shrub (willow, rose, buffaloberry), wet meadow, riverine-aquatic communities to their natural distribution and extent along the lower Carson river and Stillwater slough.	Literature Search Remote Sensing Active Management Quadrats	Riparian Habitats	Complete literature search on historic composition of riparian communities. Biannually map riparian habitat types. Establish permanent quadrats to assess within community changes.
Objective A.b.2(d)(i): Attain a long-term minimum average of 400 acres of wetland habitat in the Battleground marsh.	Remote Sensing	Riparian/Wetland Habitats	Biannually map extent of riverine delta/wet meadow habitats at the Battlegrounds.
Objective A.b.2(d)(ii): During years when water reaches the Carson river delta via Carson river, approximate natural habitat conditions.	Existing Literature Remote Sensing	Riparian/Wetland Habitats	Use existing data to estimate historic distribution of habitat types, biannually photograph and map existing types, establish permanent quadrats to track community changes.
Objective A.b.2(e): Restore, approximate, and maintain the natural distribution and abundance of upland plant communities and habitat types that would exist naturally, according to location, throughout upland portions of the refuge.	Existing Literature Remote Sensing Quadrats	Upland/Sand Dune Habitats	Use existing literature to estimate natural distribution of upland habitat types, map distribution of upland communities every five years, establish permanent quadrats to assess within community changes.
Objective A.b.3: Approximate within each habitat type and plant community, a natural species composition; emphasizing the domination of these communities by one or more native species representative of the community.	Quadrats Line Transect	Upland/Sand Dune Habitats	Establish and annually monitor permanent quadrats in upland habitats.

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Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Objective A.b.3(a): For each habitat type and plant community, determine the approximate proportion that each of the major plant species should comprise in the community, and develop targets based on this assessment.	Literature Search Quadrats	Wetland, Riparian, Upland Shrub, Sand Dune	Review existing literature to determine components of identified plant communities. Use quadrat sampling to confirm within community distribution and to define new plant communities as observed.
Objective A.b.3(b): Prevent the establishment of any nonnative species not already present within the boundaries of Stillwater NWR, especially species listed as noxious weeds (e.g., purple loosestrife, Eurasian water milfoil).	Cruising Remote Sensing Other vegetation surveys	Wetland, Riparian, Upland Shrub, Sand Dune	Use all available resources to detect presence and spread of invasive exotic species on Stillwater NWR.
Objective A.b.3(c): Curtail the spread of noxious weeds and other invasive exotic vegetation within the Stillwater NWR, and reduce the amount of area dominated by saltcedar and perennial pepperweed.	Remote Sensing Quadrats	Wetland, Riparian, Upland Shrub, Sand Dune	Remap extent of noxious weeds every five years. Establish permanent quadrats to assess success of control efforts.
Objective A.b.4: Approximate, within each habitat type and plant community, the vegetative structure of plant communities that would occur under natural operation of ecological processes (e.g., spring flooding, drought, succession and competition, accumulation of residual plant material, herbivory, seed caching, long intervals between fires).	Literature Search Remote Sensing Quadrats	Wetland, Riparian, Upland Shrub, Sand Dunes	Through literature search, determine the extent, timing and frequency of natural processes, track simulations of these processes (natural and induced through management), and establish permanent quadrats to assess plant community structure in relation to process occurrence.
Stillwater Marsh			
(i) a natural pattern of emergent vegetation and open-water areas in the marsh that is maintained by deeper channels and by disturbances such as spring flooding and muskrat grazing, or secondarily, a mosaic that simulates natural disturbances	Remote Sensing Line Transect	Emergent, Submergent, and deep open-water habitats.	Biannually map the extent of emergent, submergent, and deep open-water habitats, continue annual submergent vegetation transects to quantify structure and species composition within these communities.
(ii) portions of the marsh having residual vegetation that has accumulated for many years (e.g., five years or more).	Remote Sensing Water Mgmt Records	Wetland Habitats	Biannually map wetland habitats and track consistency of habitat types among years.
Lower Carson River and Stillwater Slough			
(i) An overstory of cottonwoods and/or willows along most stretches	Remote Sensing Quadrats	Riparian Habitats	Biannually map riparian habitat distribution, establish permanent quadrats to monitor vegetation change among years
(ii) An understory of native grasses and grass-like plants, forbs, and young cottonwoods and mesic shrubs	Quadrats Line Transects	Riparian Habitats	Establish permanent quadrats to assess changes in understory habitats not visible from aerial photographs. Potentially establish line transects to cover

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Goal	Broad Approach	Resources Monitored	Monitoring Procedures
(iii) Some areas dominated by grasses and grass-like plants (no woody overstory)	Remote Sensing Quadrats Line Transects	Riparian Habitats	Biannually map distribution of short statured habitat types. Establish permanent quadrats to assess changes in structure and species composition.
(iv) Carry-over of native herbaceous plant material from season to season and year to year during most periods, recognizing that spring flooding would naturally have matted some vegetation and induced decomposition, and that fires (late summer or fall) would have been infrequent)	Remote Sensing	Riparian and Wet Meadow Habitats	Biannually map wetland habitats to assess relative age of different habitat types and communities.
Uplands			
(i) Any overstory of native shrubs in many communities	Remote Sensing	Upland Shrub Habitats	Map distribution of perennial upland shrub habitats every five years
(ii) Extensive amounts of bare soil between shrubs in many communities	Remote Sensing Quadrats	Upland Shrub Habitats	While the potential exists to map distribution of bare soils through aerial photos, this should be verified through establishment and annual monitoring of permanent quadrats.
(iii) A build up of residual plant material from native grasses and forbs, allowed to accumulate naturally over the years (i.e., not grazed or trampled by livestock, crushed by off-road vehicles, etc...)	Quadrats Line Transects	Upland Shrub Habitats	Annually monitor permanent quadrats to assess build-up of residual vegetation. Establish line transects to assess disturbance effects on upland vegetation.
Objective A.b.5: Approximate water conditions that would occur naturally, according to location of wetland-habitat (i.e., fresh in riverine and the upper end of marsh, and brackish at the lower end of marsh), in a way that contributes toward the approximation and maintenance of the natural extent, distribution, composition, and structure of plant and animal communities.	Existing Literature Water Mgmt Records Remote Sensing	Wetland and Riparian Habitats	Assess historic hydrologic processes through existing literature search, track water receipts and irrigation data to determine our success at simulating these processes. Biannually map habitat types through aerial photography.
Objective A.b.5(a): Maintain total dissolved solids (TDS) concentrations of Stillwater NWR inflows of less than 500 mg/L during February-June and less than 1,000 mg/L during the remainder of the year. Maintain low TDS levels in the upper Stillwater Marsh (generally <1,000 mg/L) and portions of the mid and lower Stillwater marsh that are within the flow route of water (<5,000 mg/L). Off-channel areas would have much higher TDS levels, possibly approaching 100,000 mg/L.	Remote Sensing Water Quality Samples	Wetland and Riparian Habitats	Use biannual mapping to index salinity ranges through occurrence of wetland habitat types. Take monthly measurements of water conductivity in conjunction with water monitoring procedures.
Objective A.b.5(b): Minimize the amount of contaminants entering Stillwater NWR wetlands and reduce mercury levels in wetland sediments to less than 1.5 ppm (note: TDS concentrations of inflow in excess of objective levels are viewed in the context of contaminants).	Water Quality Samples	Wetland and Riparian Habitats	Cooperate with the Reno Field Office to conduct contaminant surveys annually.

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Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Subgoal A.c: Allow and provide for natural types, levels, rates, and distributions of biotic processes, such as herbivory, granivory, predation, population fluctuations of resident wildlife, and production; minimize or exclude processes not natural to the area or that are above or outside the levels, rates, locations, or communities that would occur naturally. Exceptions to this include: (1) diseases such as botulism and cholera, which would be minimized; and (2) browsing by deer and other wildlife may be controlled, to allow the reestablishment of native vegetation.	Estimate and provide descriptions of natural process occurrence levels, determine baseline departures from historic, and annually monitor identified key processes and functions.		
Objective A.c.1: Prevent grazing and browsing by nonnative herbivores that are above natural levels (use and distribution) for any given plant species and community, and season for these species and communities.	Existing Literature Cruising Grazing Exclosures	Upland, Wetland, Riparian, and Sand Dune Habitats, Livestock grazing permits	Determine relative levels and seasons of grazing under natural conditions, Cruise habitats to determine existing levels of use, biannually monitor exclosure plots and compare with quadrats established for other objectives.
Objective A.c.2: Allow native herbivores to graze and browse at natural levels (use and distribution).	Literature search Remote Sensing Indicator species census	Wet meadow and riparian habitats Mule deer, Canada geese, small mammal populations	Search literature to estimate natural population levels of native herbivores. Estimate availability of wet meadow and riparian habitats relative to forage availability. Monitor population levels of mule deer, Canada geese, and small mammals as indicators of natural herbivory.
Objective A.c.3: Prevent depredation of nests above natural levels when caused by unnaturally high populations of predators. (This objective does not include taking action when other factors are causing unnaturally high depredation rates, such as lowered habitat quality.)	Existing Literature Remote sensing Predator surveys	Upland, Wetland and Riparian habitats	Determine availability of upland and over-water nesting habitat. Perform literature search to estimate natural population levels for common raven and coyote. Monitor common raven and coyote populations on the refuge.
Objective A.c4: Prevent human disturbances that would measurably affect the use of the refuge by native wildlife, nest success of waterbirds and riparian birds, overall production, daily activity patterns of birds, use of important feeding habitats by waterbirds during migration and winter and the nutritional status of these birds, and other biotic processes.	Public Use Monitoring Distribution Census Time Activity Budget	Wetland and Riparian Habitats	Determine for each activity, timing, frequency, and relative use level within different refuge habitat types. Correlate these activities with wildlife distributions collected for the waterbird chronology census, potentially provide opportunity for outside research related to wildlife behavior in response to disturbance types and levels.

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Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Objective A.c.4(a): Maintain a minimum of 60 percent of the refuge's wetland-habitat in sanctuary and other areas providing secure habitat, combined, such that (i) all life-history requirements of all major waterbird guilds are contained in the selected areas; (ii) a minimum of 4,000 acres are in sanctuary (no public access), and (iii) the "other secure areas" provide relatively secure feeding, resting, and breeding habitat for waterbirds.	Remote Sensing Distribution Census Time Activity Budget	Wetland and Riparian Habitats	Biannually map distribution of major wetland habitat types, Determine waterbird distribution among protected and unprotected areas, potentially provide opportunity for outside research related to wildlife behavior in response to disturbance types and levels.
Objective A.c4(b): Minimize human-disturbance to wildlife in areas outside the sanctuary while still providing opportunities for compatible wildlife-dependent recreation.	Public Use Monitoring Distribution Census Time Activity Budget	Upland, Wetland, Riparian, and sand dune habitats.	Determine for each activity, timing, frequency, and relative use level within different refuge habitat types. Correlate these activities with wildlife distributions collected for the waterbird chronology census, potentially provide opportunity for outside research related to wildlife behavior in response to disturbance types and levels.
Subgoal A.d: Fill information gaps with knowledge gained through monitoring, management studies, and research (including archaeological and paleoenvironmental investigations, and assessment of historical records), and assess the effectiveness of management actions and identify needed modifications to the management program.	Perform literature search from historic documentation to determine current level of understanding among biological communities, ecological processes, and historic functions. Where required, perform additional studies to obtain baseline information on poorly understood components.		
Objective A.d.1: Within five years, estimate the natural, relative level of abundance of all native species of fish and wildlife within Stillwater NWR (e.g., rare, accidental, uncommon, common, abundant), including natural variability over time.	Literature Search	All Native Wildlife Species	Where information exists, obtain estimates of native wildlife population levels, available life history information, and seasons of use for each species.
Objective A.d.2: Design management studies and modify the monitoring program, as needed, to ensure that major components of biodiversity, including key taxa of wildlife and vegetation diversity, are being adequately monitored and to evaluate the effectiveness of management actions undertaken by the Service.	Various Censuses Key Species Indicators	All native wildlife and vegetation communities	Develop flexible monitoring strategy, using indicator species approach to assess population/vegetation community dynamics in relation to our management actions. Assess effectiveness of monitoring strategies every five years.
Objective A.d.3: Design and implement baseline inventories of birds, amphibians, aquatic and terrestrial invertebrates (e.g., butterflies), and plants within three years along the lower Carson River and its delta, Stillwater Slough, Battleground Marsh, dunes, and nearby salt desert shrub areas to provide baseline information to assess the effects of habitat restoration efforts, including exclusion of cattle from riparian and upland areas.	Literature Search Various Censuses	Upland, Riparian, Wetland, and Sand Dune Habitats. Species where data are lacking.	Conduct literature search to determine which native species do not have sufficient data to assess response to management strategies. Design baseline inventory techniques to fill identified gaps.

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Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Objective A.d.4: Estimate the natural geomorphology, hydrology, and habitat composition of the lower Carson River and the Battleground Marsh, in a way that recognizes natural year-to-year variations.	Literature Search Remote Sensing	Riparian and Wetland Habitats	Conduct literature search to identify historic processes and habitat compositions common to the Carson River and Battleground marsh. Biannually map habitat distribution.
Objective A.d.5: Estimate the natural composition, structure, and distribution of upland plant communities, and design and implement an inventory to determine the existing conditions of these parameters.	Literature Search Line Transect Quadrats	Upland Habitats	If possible, conduct literature search to determine natural structure and composition of upland plant communities. Establish permanent vegetation quadrats to monitor change in relation to our management actions.
Objective A.d.6: Assess whether the adopted sanctuary and other areas managed to provide security for waterbirds are of sufficient size and encompass adequate breeding habitat for waterbirds, and feeding and loafing habitat for migrating and wintering waterfowl; and whether an adequate amount of secure habitat is provided in the walk-in only hunt area of Option C2.	Public Use Monitoring Distribution Census Time Activity Budget	Wetland and Riparian Habitats	Determine for each activity, timing, frequency, and relative use level within different refuge habitat types. Correlate these activities with wildlife distributions collected for the waterbird chronology census, potentially provide opportunity for outside research related to wildlife behavior in response to disturbance types and levels.
Objective A.d.7: Research ways to provide wetland-unit drawdowns during July-September in ways that mimic natural water-level declines and that accomplish habitat objectives, but do not contribute to significant avian botulism outbreaks (adapted from Nevada Partners in Flight Plan).	Existing Literature Remote Sensing Water Monitoring Disease Monitoring	Wetland Habitats	Determine the factors associated with botulism outbreaks at Stillwater NWR, identify units of concern based on past documentation, and develop water management strategies to minimize factor occurrence on identified wetlands units of concern.
Objective A.d.8: Investigate the habitat needs, especially nesting habitat, of snowy plovers.	Snowy Plover Census Outside Research	Playa Habitat Type	Continue annual census of snowy plover habitats to provide an index of relative population levels, provide opportunities for outside research to determine life history requirements while on the refuge.
Objective A.d.9: Participate in the comprehensive state-wide survey of potential nesting sites of black terns using professional and volunteer personnnel, as well as conduct an assessment of the role that Stillwater Marsh played in black tern ecology in the Great Basin (from Nevada Partners in Flight Plan).	Literature Search Distribution Census	Black Terns	Review existing literature to determine recent documentation (1959 to present) of black tern populations and nesting. Participate in state wide survey.
Objective A.d.10: Ascertain whether Nevada viceroys and Carson wandering skippers (butterflies) inhabit Stillwater NWR, and determine more precisely their habitat requirements.	Cruising Baseline Census Outside Research	Upland and Riparian Habitats	Use existing study to develop annual monitoring plan for important refuge butterfly species. Provide opportunity for outside researchers to collect life history information for these and other butterfly species.
Goal B: Contribute toward fulfilling obligations of international treaties and other international agreements with respect to fish and wildlife.			

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Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Subgoal B.a: Prevent and abate pollution and detrimental alterations of native plants and animals including (1) preventing the introduction of nonnative plants and animals, (2) preventing the spread of introduced species that have become established, and (3) eradicate, to the extent possible, existing populations of nuisance species.	Continue to map through remote sensing, distribution of invasive species, use cruising to identify locations suitable for establishment of invasive species not currently present, and record treatments used and acres treated within existing invasive species dominated communities to determine relative success of control measures.		
Subgoal B.b: Restore, preserve, and conserve natural ecosystems and habitats for migratory birds, other animals, plants, other components of biodiversity, and for the protection and conservation of natural areas.	Use a combination of remote sensing, line transects, quadrats and wildlife population censusing techniques to determine relationships between wildlife and habitats, and relative proportion of non-native and native components within communities.		
Subgoal B.c: Ensure that public use does not detract from the Service's ability to achieve wildlife related refuge purposes and that it is consistent with conservation and sustainable use principles: and ensure that sufficient sanctuary is provided for waterfowl using the Lahontan Valley, which may require additional study.	NDOW Census Distribution Census Outside Research	Wetland and Riparian Habitat. All Waterfowl Species.	Determine relative abundance of waterfowl species utilizing all major wetland areas in the Lahontan Valley during fall/spring migration (NDOW). Determine the distribution of waterfowl species among sanctuary and public use areas in conjunction with chronology census. Provide opportunity and participate in proposal development for outside research project to assess waterbird security provided by pilot refuge public use options.
Subgoal B.d: Provide for the needs of migrating and breeding shorebirds as part of the Western Hemispheric Shorebird Reserve Network, in ways that are consistant with the approach prescribed under Goal A.	Continue annual monitoring programs to identify levels of utilization by common shorebird species. Develop specific monitoring protocol for collection of migration chronology and key species information.		
Objective B.d.1: Provide high-quality nesting and brood-rearing habitat for shorebirds and other waterbirds in consideration of habitat availability in other parts of the Lahontan Valley and throughout the Interior Basins ecoregion.	Remote Sensing Distribution Census	Upland, mud flat, and playa habitats. Key shorebird breeding species.	Biannually map the distribution of upland (adjacent to wetlands) and mudflat/playa habitats. Determine waterbird distribution among these habitats through annual ground census.
Objective B.d.2: Provide high-quality shorebird habitat during spring and fall migration, including rising water levels during spring and declining levels during the late summer and fall.	Remote Sensing Distribution Census	All shallow, lightly vegetated wetland habitats. Key shorebird migratory species.	Biannually map the distribution of upland (adjacent to wetlands) and mudflat/playa habitats. Determine waterbird distribution among these habitats in conjunction with waterbird migration chronology census.
Subgoal B.e: Provide high-quality habitat for migrating, breeding, and wintering waterfowl, to the extent that it does not measurably conflict with subgoals and objectives of Goal A.	In conjunction with the Nevada Division of Wildlife, continue collecting waterfowl population data during critical times of the year. Use habitat maps to estimate habitat availability for these populations.		

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Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Objective B.e.1: Provide high-quality nesting and brood-rearing habitat for waterfowl and other waterbirds.	Remote Sensing Distribution Census	Upland, Wetland, and Riparian Habitats. All nesting waterfowl species.	Biannually map distribution of Wetland, Riparian, and upland habitats adjacent to wetlands. Conduct annual waterfowl pair count (NDOW) and brood surveys throughout wetland habitats. Assess upland nesting habitat quality through establishment of permanent vegetation quadrats.
Objective B.e.2: Provide high-quality wetland waterfowl-habitat during fall and winter, until wetland units ice over (generally late December or January).	Remote Sensing Distribution Census	Wetland and Riparian Habitats	Biannually map the distribution of all wetland habitats. Continue refuge-wide monthly waterfowl counts (NDOW). Compare migration chronology data with wetland unit habitat juxtaposition to index waterfowl distributions.
Objective B.e.3: Minimize the occurrence, spread, and severity of botulism and cholera outbreaks.	Botulism Monitoring	All waterbird species susceptible to botulism	Continue refuge wide botulism patrols to determine annual locations and mortality rates. Analyze these data to determine chronology of events and consistent "hot spots".
Objective B.e.4: Ensure that suitable wetland habitat is provided for other marsh dependent species, using white-faced ibis, black terns, American white pelicans, Clark's grebes, and short-eared owls as indicators.	Distribution Census Remote Sensing	Waterbird indicator species. Wetland habitats	Biannually map the distribution of wetland habitat types, particularly those of importance to wetland indicator species. Record indicator species numbers bimonthly in identified index wetlands. Compare annual counts with wetland habitat acreage to determine habitat/indicator species relationships over time.
Subgoal B.f: Provide high quality habitat for migrating and breeding birds in riparian areas and salt desert shrub communities in ways that are consistent with the overall approach prescribed under Goal A.	Using a combination of remote sensing, line transect, plot sampling, and point count methodology, annually index habitat quality and avian species response to document long term trends in habitat suitability for upland and riparian wildlife species.		
Objective B.f.1: Provide high quality habitat for neotropical migratory birds associated with riparian areas in ways that are consistent with the overall approach prescribed under Goal A, using yellow-billed cuckoos, ash throated flycatchers, blue grosbeaks, yellow breasted chats, and western bluebirds as indicator species.	Remote sensing line transects quadrats point count	Riparian habitats indicator species	Map distribution of riparian habitats every three years, and collect plant community and vegetative structure information from line transects and permanent quadrats annually. Record spring/fall abundance of identified riparian indicator species using point count methodology.
Objective B.f.2: Provide high quality habitat for birds associated with salt desert shrub areas in ways that are consistent with the overall approach prescribed under Goal A, using loggerhead shrikes and burrowing owls as indicator species.	Remote sensing line transects point count	Upland shrub habitats indicator species	Map distribution of upland habitats every five years, and collect plant community and vegetative structure information from line transects annually. Record spring/fall abundance of identified upland indicator species using point count methodology.

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Goal	**Broad Approach**	**Resources Monitored**	**Monitoring Procedures**
Subgoal B.g: Restore, enhance, and protect habitat for threatened and endangered species, species of special concern, and other sensitive, rare, or endemic species.	Perform literature search for key species to enrich our understanding of species specific habitat requirements. Develop monitoring protocol for each identified key species. Develop studies to determine if additional species require special protection (e.g., rare plant survey, amphibian surveys, etc...)		
Objective B.g.1: Within the next five years, reestablish, in a way favorable for future roosting by bald eagles (including a suitable distance from areas accessible to the public), cottonwood trees in the Timber Lakes area, and reestablish similar stands along other parts of the Carson river as additional lands are acquired.	Remote Sensing Vegetation Transects	Riparian Habitat, Bald Eagles	Annually map distribution of cottonwoods along riparian corridors. Conduct monthly Bald Eagle roost survey during winter, to determine annual population levels
Objective B.g.2: During the interim until their habitat needs are better delineated, provide shallowly flooded, unvegetated playa habitat for snowy plover nesting in areas they have used in the past.	Remote Sensing Snowy Plover Census	Playa Habitat, Snowy Plover	Annually map the distribution of playa and open mud flat habitat throughout the refuge. Annually census the distribution of snowy plover among these habitats.
Objective B.g.3: Within the next five years, reestablish native willow and mesic shrub communities along the Carson River in the Timber Lakes area for the benefit of Nevada viceroys and other riparian shrub species of special concern, and reestablish such communities along other parts of the Carson River as additional lands are acquired along the Stillwater Slough.	Remote Sensing Cruising Vegetation Transects	Riparian Habitat, Riparian related invertebrate, bird, and amphibian species	Annually map the distribution of riparian habitats. Establish permanent quadrats to assess communtiy changes in response to management activities. Support quadrat information with line transects to cover a wider area of the riparian corridor. Adjust restoration techniques to incorporate new information on needs of riparian wildlife species.
Anaho Island NWR			
Goal A: Protect and perpetuate colonial-nesting birds and other migratory birds.	Monitor chronology, relative population levels, and nesting success for all colonially nesting species at Anaho Island, monthly throughout the breeding season. Annually band approximately 400 juvenile American white pelicans.		
Objective A.1: Provide a sufficient amount of nesting habitat, free from human disturbance and other threats, for colonial-nesting birds during the breeding season.	Remote Sensing Pyramid Lake LE	Colonies, all colonial nesting waterbirds	Annually map colony distribution on Anaho Island NWR. Consult with Pyramid lake tribal police to obtain citations issued for trespass violations to index relative levels of disturbance?
Objective A.2: Prevent the formation of a land bridge between Anaho Island and the eastern shoreline of Pyramid Lake.	Remote Sensing Lake Water Levels	Hydrology	Annually map the acreage and habitat types of Anaho Island NWR. Obtain Truckee river input amounts and annual water level from Pyramid Lake tribe.

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Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Objective A.3: Closely monitor the breeding population of each colonial-nesting species (white pelicans, double-crested cormorants, gulls, herons, and egrets) to track the number of nesting pairs, hatchlings, and fledglings each year.	Ground Census	All colonial nesting species.	Through the breeding season, obtain monthly counts of nests, adults, and juveniles to allow for evaluation of chronological and breeding success trends.
Objective A.4: Promote research opportunities that would increase the Service's understanding of colonial-nesting birds, their life history requirements and potential contaminant problems.	Outside Research	All colonial nesting species.	Provide opportunity and participate in proposal development for outside research projects pertaining to colonial nesting waterbird life history information.
Goal B: Restore and maintain natural biological diversity.			
Objective B.1: Restore and maintain a natural composition and structure of vegetation.	Literature Search Remote Sensing Vegetation Transects	All island vegetation types	Perform a literature search to estimate type and relative abundance of native habitats common to Anaho Island. Annually map the distribution of habitat types, and establish quadrats or line transects to assess change in community structure over time.
Objective B.2: Provide research opportunities that would enhance the effectiveness of restoring a natural composition and structure of vegetation, including research that explores the detrimental impacts of red brome, cheatgrass, and other invasive nonnative plants and possible ways to control these species.	Outside Research	Identified Native Vegetation Communities.	Provide and participate in proposal development for outside research projects pertaining to native vegetation community dynamics, vegetative species life history information, and/or exotic vegetation control.

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APPENDIX E:
Waterfowl Analysis

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An Analysis of Stillwater NWR Waterfowl Use Data

1970-1998

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January 11, 2000

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Analysis of Stillwater NWR Waterfowl Use Data
1970-Present

Introduction

As a guild, waterfowl have been one of the primary target species for which Stillwater NWR habitat management has been focused. The original refuge establishing authority (Tripartite Agreement 1948), lists provision of a public shooting ground (predominately for waterfowl hunting) as a coequal purpose with livestock grazing and the conservation of fish, wildlife, and their habitats. This 50 year agreement dissolved in November 1998, leaving the refuge with a new set of purposes (Title II of Public Law 101-618) where waterfowl management is now one component of management for natural biological diversity and waterfowl hunting is now coequal with five other priority public uses outlined in the National Wildlife Refuge System Improvement Act (1997). To ensure that potential adverse impacts to waterfowl populations and the hunting public through changes in management authority are adequately addressed, it is necessary to examine long-term waterfowl population/habitat information.

While the refuge has accumulated considerable habitat information from several different sources, the Nevada Division of Wildlife (NDOW) was consulted to acquire seasonal waterfowl population data. These data were collected using the same observer (Nevada State Waterfowl Biologist Norm Saake) and survey routes over a 22 year period. Funding and time limitations led to some inconsistency in data collection schedules but most months were sampled between 1977-present. The following are the results of a preliminary analysis of this information, as it applies to Stillwater NWR.

Methods and Materials

Data were organized into spreadsheet format with waterfowl species numbers by month, year, and wetland acreage recorded for years where this information was available. Values in the final spreadsheet were compared with raw data, to check for data entry errors and/or sample periods where complete surveys were not conducted. In some cases, observation limitations allowed for only a subsampling of refuge wetland habitats and these observations were subsequently truncated from the data set. Only complete observations were used in the following analyses, resulting in a data set which roughly covered 1977-1998, inclusive.

The 14 refuge wetland units were pooled into sanctuary and open area blocks, to facilitate analyses comparing species specific, seasonal distribution effects and to decrease variability in the data set. It was assumed that data collection procedures were consistent among sample sessions and that the strength of these procedures allowed for some descriptive analysis of patterns and trends. Descriptive analyses were used to examine seasonal waterfowl population trends and wetland acreage. To examine waterfowl distribution among pooled, open and sanctuary units, waterfowl density was calculated and median, monthly values among years were used. The following section explains statistical procedures used in the analysis.

A set of two-factor (sanctuary [hunted and non-hunted wetlands] and month) analyses of variance (ANOVAs) were used to compare densities of aquatic migratory bird. ANOVA's were run only for those species where >50% of the surveys had values for them. Because heterogeneity of treatment variances could not be reduced by transformations, raw values were replaced with ranks to run ANOVA's (Iman 1982). If month-by-sanctuary interactions were found for these two-ANOVA's, we ran ANOVA's on smaller data sets, so results would not be confounded by them. For example, because the month-by-sanctuary interaction and sanctuary terms were significant from the two-factor ANOVA for green-winged teal, densities between sanctuary and non-sanctuary wetlands were compared separately for each month with one-factor ANOVA's. If no interaction was found, values were calculated as the median of cell (month or sanctuary and non-sanctuary wetlands) medians. Bonferroni simultaneous confidence interval and Tukey's tests were used to separate medians where differences were found for two-factor ANOVA's with and without interactions, respectively. For species with a month-by-sanctuary interaction and months where >50% of surveys had zero values (e.g., canvasbacks in August [Table 1]), Fisher's exact test was used to compare frequencies of surveys with birds recorded (>0) between sanctuary and non-sanctuary wetlands. SAS (SAS Institute Incorporated 1989) was used to run statistical tests and compute test statistics. All statistical tests were run at ∝ = 0.050.

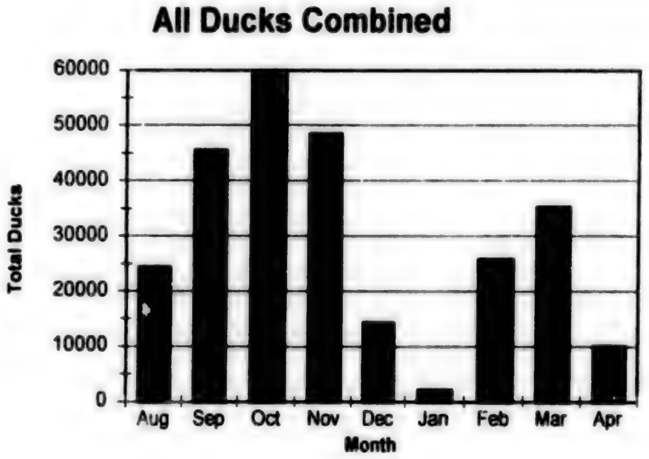
Results

Waterfowl Population Chronology

Duck populations were censused on Stillwater NWR at varying intervals from the onset of fall migration (mid-late August) through spring migration (April). Peak populations have ranged between 210,260 (15 Sept. 1995) and 0 total ducks, which occurred during a mid January freeze in 1988. Average populations by month were variable with the highest total counts occurring through the fall. Figure 1 displays the median, monthly duck population, from the 22 year observation period. The number of counts used to calculate these averages are as follows:

Aug - 17
Sep - 17
Oct - 16
Nov - 21
Dec - 20
Jan - 17
Feb - 9
Mar - 11
Apr - 10

Figure 1: Median total duck population by month for Stillwater NWR, 1977-1998.



Monthly median populations range from 2,170 (January) to 59,707 (October), with the highest average counts recorded

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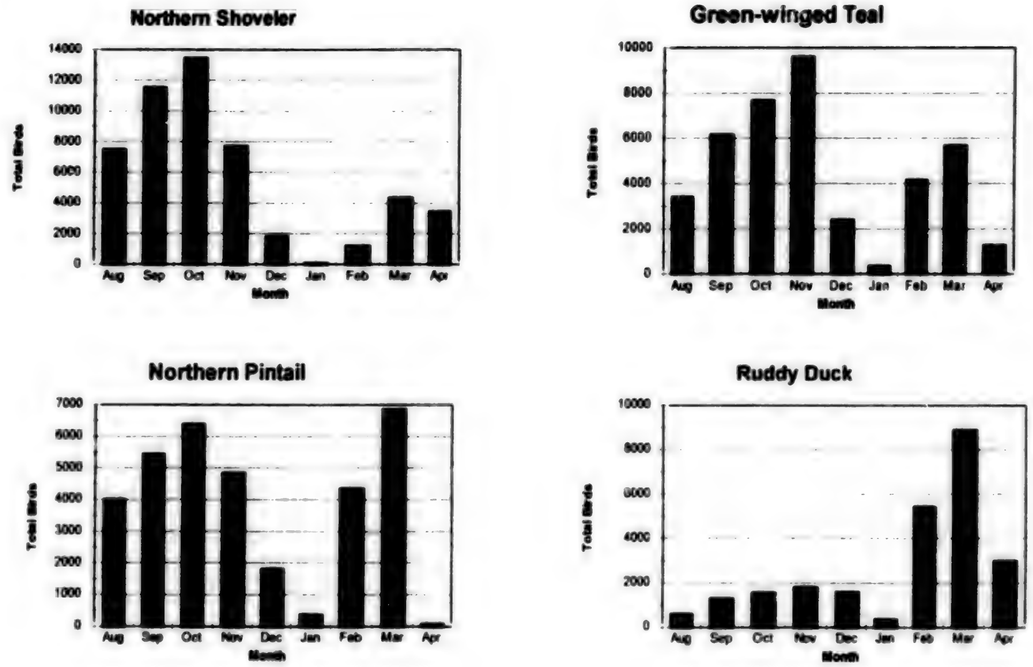
during the fall. Of 14 counts where peak population exceeded 100,000 total ducks, 13 were recorded between August and December.

As would be expected, most individual species also experience peak populations during fall including northern shoveler (*Anas clypeata*; 13,472 - October), green-winged teal (*Anas crecca*; 9,627 - October), and all other ducks except ruddy ducks (*Oxyura jamaicensis*) and northern pintail (*Anas acuta*; 8,920 and 6,885, in March, respectively). While ruddy ducks are clearly a spring migrant, northern pintails experience similar population levels in October (6,400) and March. Graphs for each of these species are presented in figure 2.

Figure 2: Median monthly population for the most common duck species using Stillwater NWR wetland habitats, 1970-98.



When examining these numbers, it is important to remember that over the last five years, we have experienced large wetland acreage associated with above average snowpack in the Sierra Nevada's. These average population statistics include drought periods as well with average wetland acreage ranging from 9,341 (November) to 11,971 (April), for years where water information was available (figure 3). Duck numbers observed during the past 5 high water years are not indicative of historic waterfowl use (the last thirty years) but, could be a glimpse at population trends to be expected at completion of the water rights acquisition program.

When averaging the past five years, wetland acreage ranged from 8,727 (November) to 14,048 (April) which includes seasonally flooded habitats in the Big Water Unit and at the Carson river

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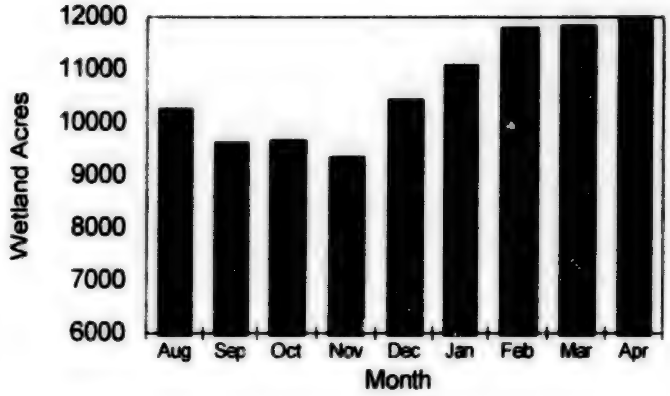
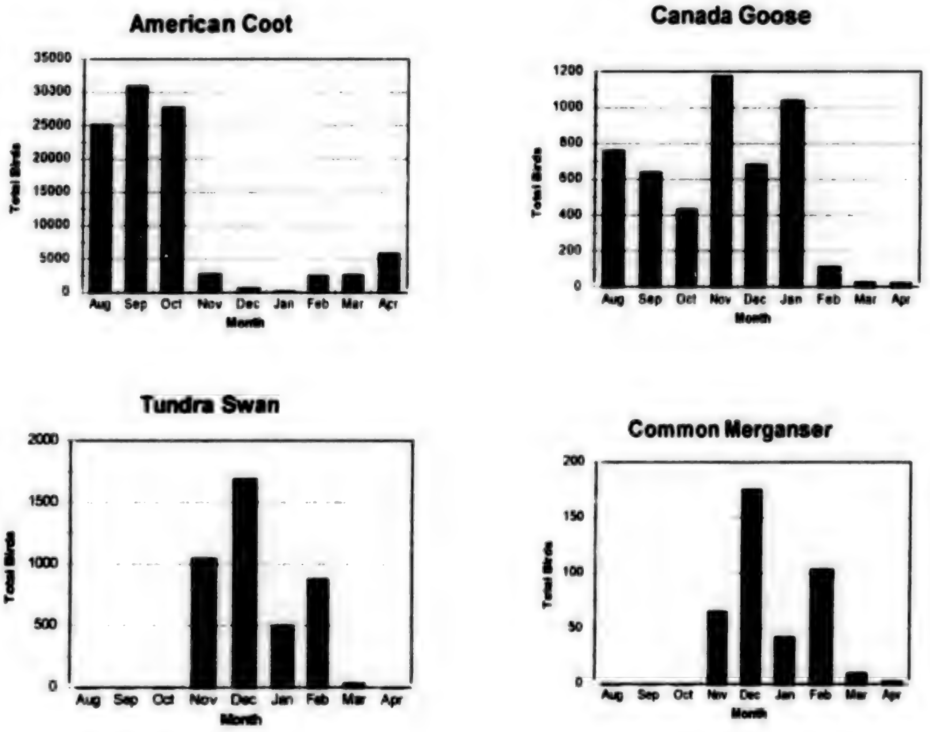
delta in Fallon NWR. Wetland acreage estimates were inconsistently recorded; therefore, only a subset of wetland acreage estimates were used in this analysis covering roughly 14 years within the 22 year period.

Figure 3: Average monthly wetland acreage at Stillwater NWR, 1977-98.



While duck species were the primary focus of these surveys, other waterfowl species including geese, mergansers (*Mergus merganser*), coots (*Fulica americana*), and swans *(Cygnus columbianus*) were censused (figure 4). Similar to most other duck species,

Figure 4: Median population of other waterfowl species censused on Stillwater NWR wetland habitats, 1977-98.



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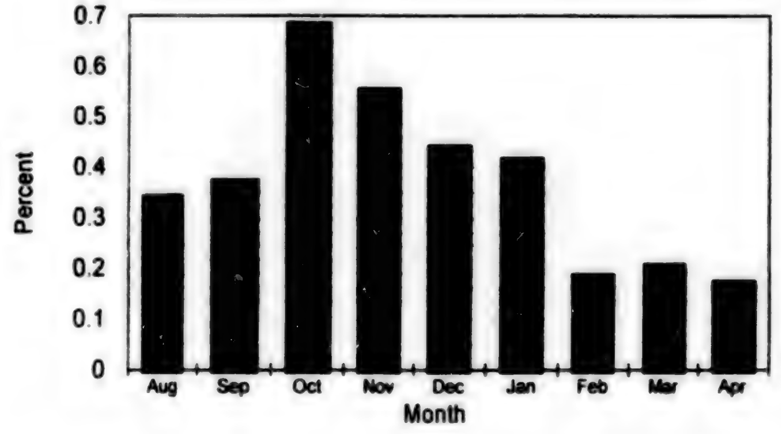
the peak coot population was recorded during fall (30,910 - September). Canada geese (*Branta canadensis* var. *moffiti* and var. *parvipes*) and tundra swans were primarily winter residents, both experiencing population peaks in November and December (1,175 and 1,038, respectively). Common mergansers (*Mergus merganser*) were similar in winter representation, but appear to stay for longer periods, eventually building to a median peak population of 175 in December. Mergansers were not surveyed outside of September - April.

Seasonal Distribution of Duck Species

To provide some initial information on seasonal distribution of waterfowl using sanctuary and non-sanctuary wetland units, an analysis of total waterfowl using each area by month was performed (figure 5). Percent duck use in sanctuary units ranged from 0.175 (April) to 0.687 (October) with hunting season apparently having an effect on distribution. Over 61% of the total waterfowl population was surveyed on sanctuary wetland units during hunting season compared to 28% during non-hunted months.

Figure 5: Median monthly percentage of duck species using sanctuary habitats at Stillwater NWR, 1977-98.



During fall migration, species composition within sanctuary and non-sanctuary units is fairly similar with a few notable exceptions (figure 6). First, although composition is similar, all species display higher sanctuary populations in October with northern pintail and American wigeon increasing in non-sanctuary units during November and December. All other species increase proportionally throughout hunting season, in sanctuary habitats, with Canvasback showing a strong preference for sanctuary habitats during October - December.

It should be understood that these percentages are associated with total waterfowl numbers and do not consider acreage provided between the compared habitat blocks (sanctuary and non-sanctuary). On average, sanctuary wetlands comprise roughly 1/3 of total wetland acreage, thus, the 35% frequency in August (figure 5) would represent equal proportions of waterfowl species using sanctuary and non-sanctuary units. Conversely, approximately 69% of waterfowl species frequent sanctuary habitats during October with similar distribution occurring until February.

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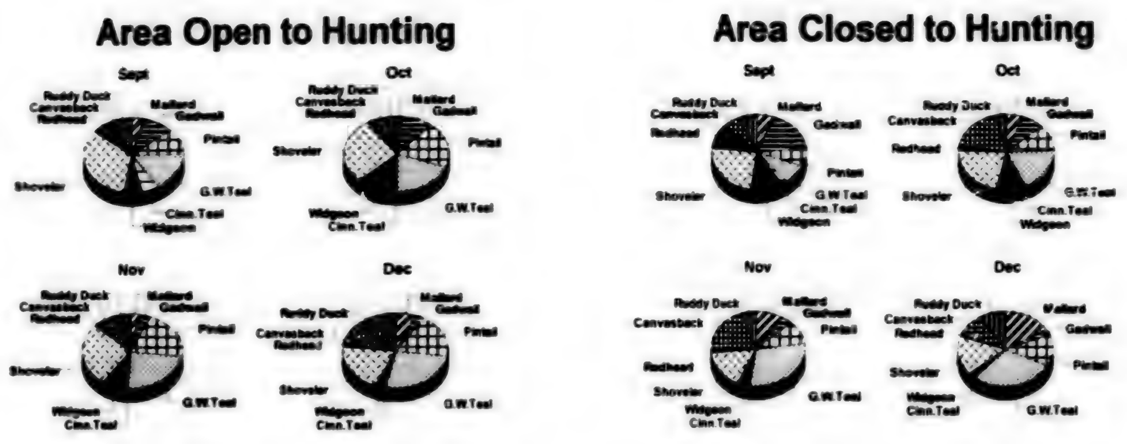
Figure 6: Proportional use of sanctuary and open public use wetland units by species at Stillwater NWR, 1970-98.



Unit	month	Mallard	Gadwall	Pintail	G.W.Teal	Cinn.Teal	Widgeon	Shoveler	Redhead	Canvasba	Ruddy Du
Open	Sept	1246	3023	3636	5103	1860	1864	10744	2319	165	1925
Open	Oct	363	2707	5515	5486	114	3449	7981	828	764	979
Open	Nov	460	610	3307	3839	7	1401	4443	289	743	1051
Open	Dec	452	220	1466	2001	6	223	1623	126	180	1498
Sanctuary	Sept	1251	3724	1593	1770	399	2346	5278	2299	1265	1391
Sanctuary	Oct	2996	3802	6022	9809	177	5090	11603	1386	9485	1989
Sanctuary	Nov	2558	1071	2749	8332	6	1262	4764	274	5889	1381
Sanctuary	Dec	2061	320	1690	3598	68	274	2144	90	1264	1097

Figure 7 illustrates the seasonal acreage provided in both sanctuary and non-sanctuary units. Average monthly wetland acreage ranges from 9,341 acres in November to 11,972 acres in April while median values range from 7,793 in March to 15,724 acres in April. Wetland acreage was calculated from a subset of years in which total acreage was estimated, and the set of years recorded vary by month. For example, March estimates were calculated from a set of seven years where low water availability was more frequently the case. Conversely, February and March acreage was calculated from a set of years where higher flows into the refuge were recorded. This factor has likely skewed wetland acreage distribution but should have less effect on waterfowl density estimates. Therefore, acreage estimates presented in this paper should not be used as an indicator of wetland coverage over the 30 year period, but instead, should be used as an index of wetland habitat acreage to be compared with known waterfowl populations.

Total waterfowl density varied by month and unit with a low of 0.35 birds/ha (0.14 birds/ac) recorded on open habitats in January, and a high of 36.33 birds/ha (14.71 birds/ac) in sanctuary habitats during October (figure 8). American coots account for roughly 25% of this total with waterfowl species peaking at 20.67 birds/ha (8.37 birds/ac), also in October sanctuary units.

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When duck totals are examined, all months except March have experienced higher waterfowl densities on sanctuary habitats.

Other species displayed mixed seasonal responses with all species exhibiting an increased preference for sanctuary habitats during hunting season (Table 1). Green-winged teal, northern shoveler, northern pintail, and gadwall (*Anas strepera*) appear to utilize sanctuary and non-sanctuary units with equal frequency prior to hunting season (figure 9). However, mallards *(Anas platyrhynchos*), redheads (*Aythya americana*), and Canada geese exhibit higher densities within sanctuary habitats across all seasons (figure 10). For all species, sanctuary

Figure 7: Median and average monthly wetland acreage recorded by total, open, and sanctuary habitats, Stillwater NWR, 1977-1998.

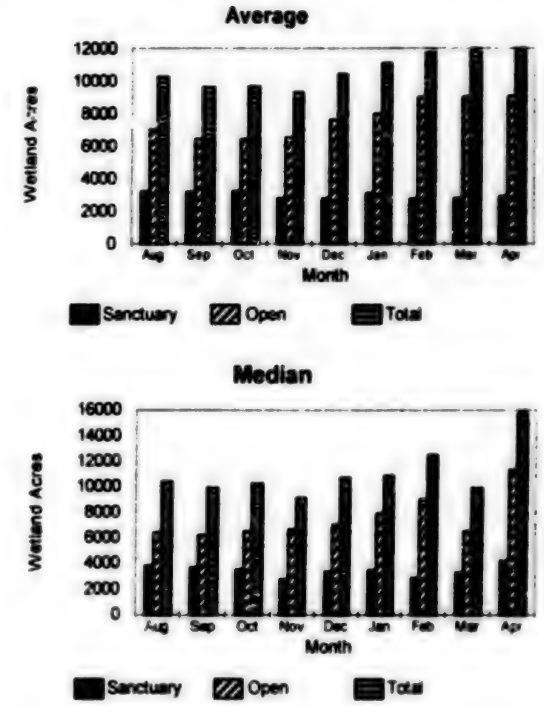

Figure 8: Median, monthly total waterfowl and coot density on open and closed public use habitats at Stillwater NWR, 1977-98.

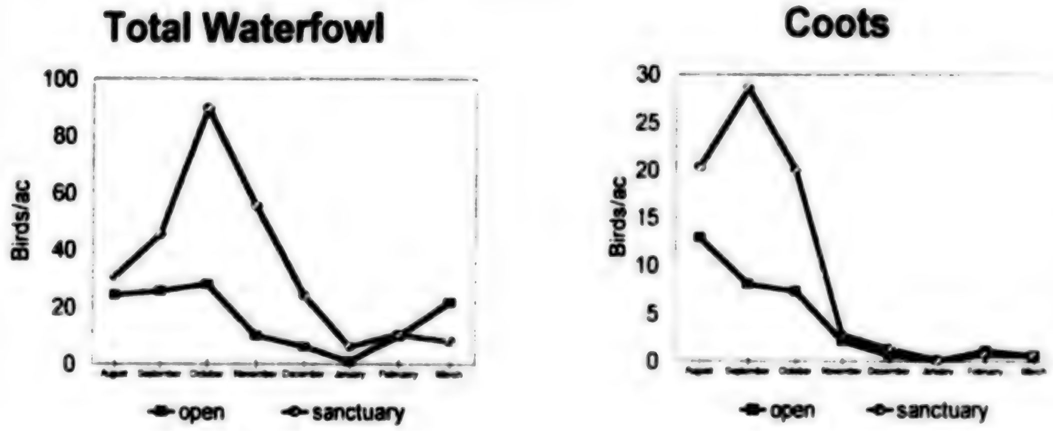

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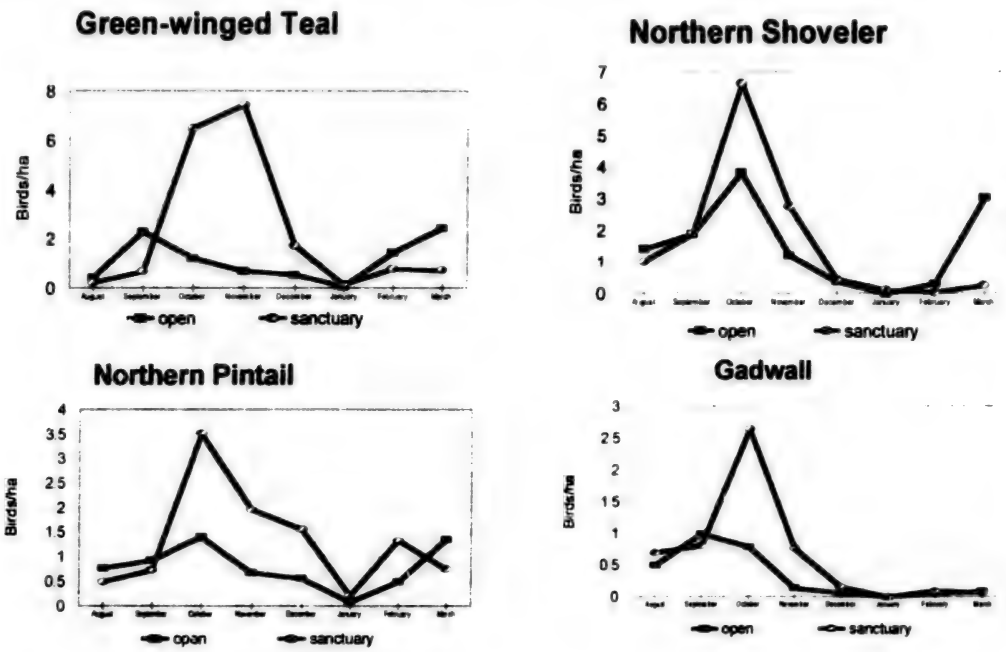
Figure 9: Density (birds/ha) estimates for species showing no apparent preference for sanctuary or open habitats prior to hunting season at Stillwater NWR, 1977-98.



density increases during hunting season months, but it would appear that sanctuary units are preferred throughout the year by at least the herbivorous waterfowl species (figure 11).

Figure 10: Density (birds/ha) estimates for species showing an apparent preference for sanctuary habitats prior to hunting season at Stillwater NWR, 1977-1998.

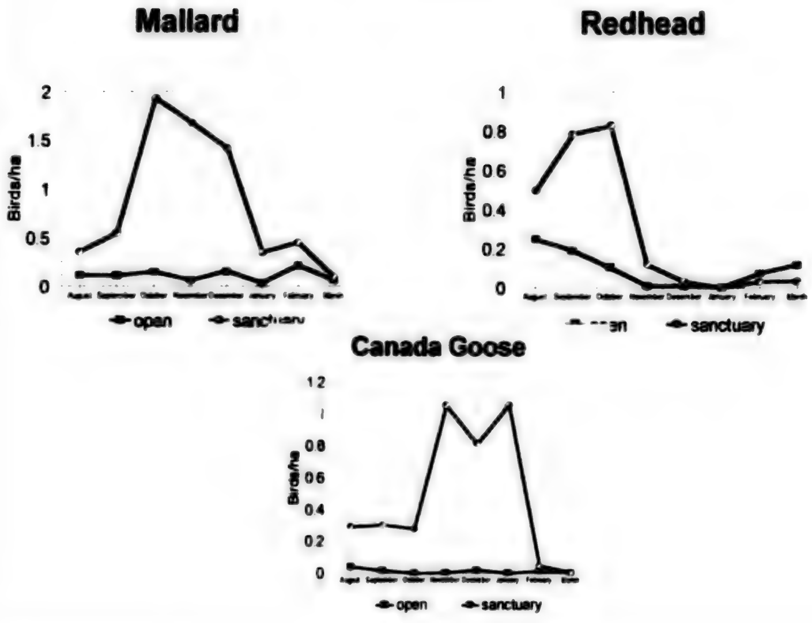


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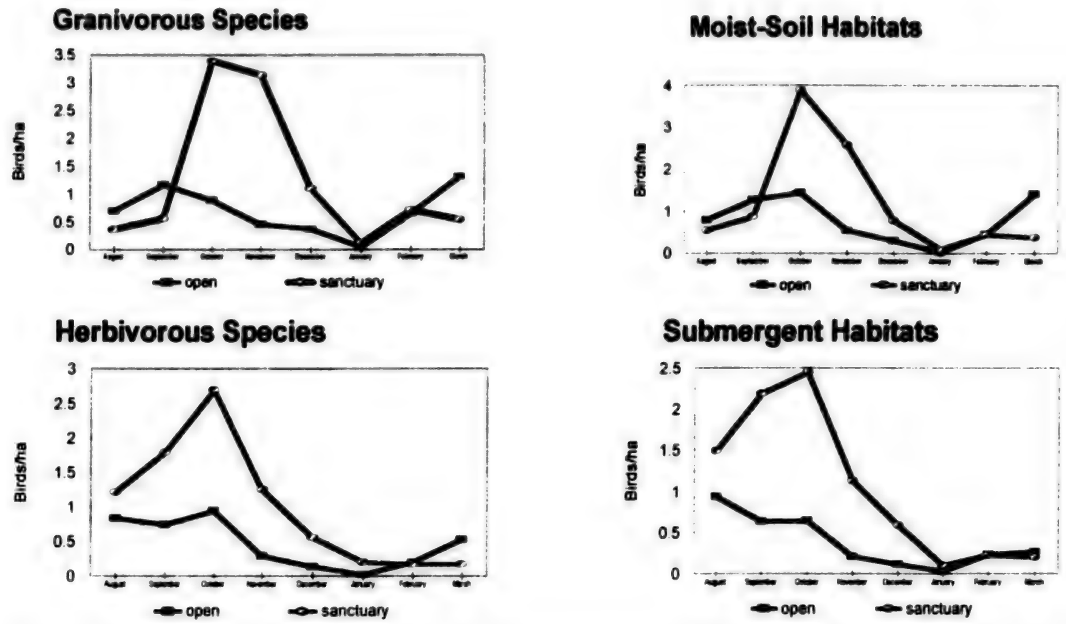
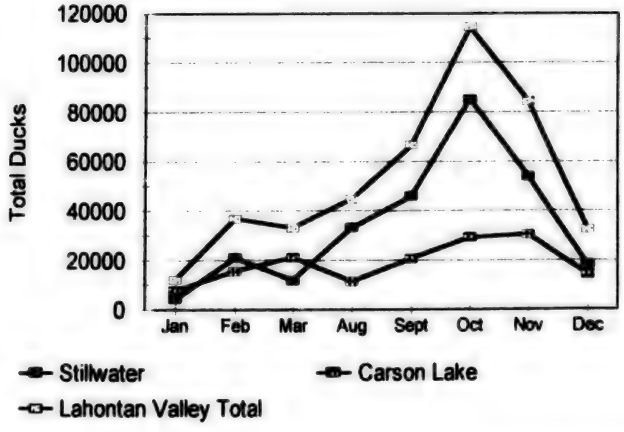
Figure 11: Density (birds/ha) of waterfowl using sanctuary and open public use units, by foraging guild and habitat type preference at Stillwater NWR, 1977-98.



Carson Lake and Stillwater Marsh

The Lahontan Valley is comprised of three primary wetland areas: Stillwater NWR, Carson Lake, and the Fallon Paiute-Shoshone tribal wetlands, along with scattered irrigation reservoirs, canals, drains, and playas. Of these areas, Stillwater NWR and Carson Lake are the most important for waterfowl. These two areas differ somewhat in management purposes; however, the combined efforts lead to provision of a Lahontan Valley wetland habitat complex which provides for the seasonal requirements of a variety of waterbirds.

Figure 12: Lahontan Valley, Stillwater NWR, and Carson Lake average duck counts for the period August - March, 1970-98.



Totals for each area and combined Lahontan Valley totals tend to mirror previously described trends, with peak duck counts occurring in October, and then dropping

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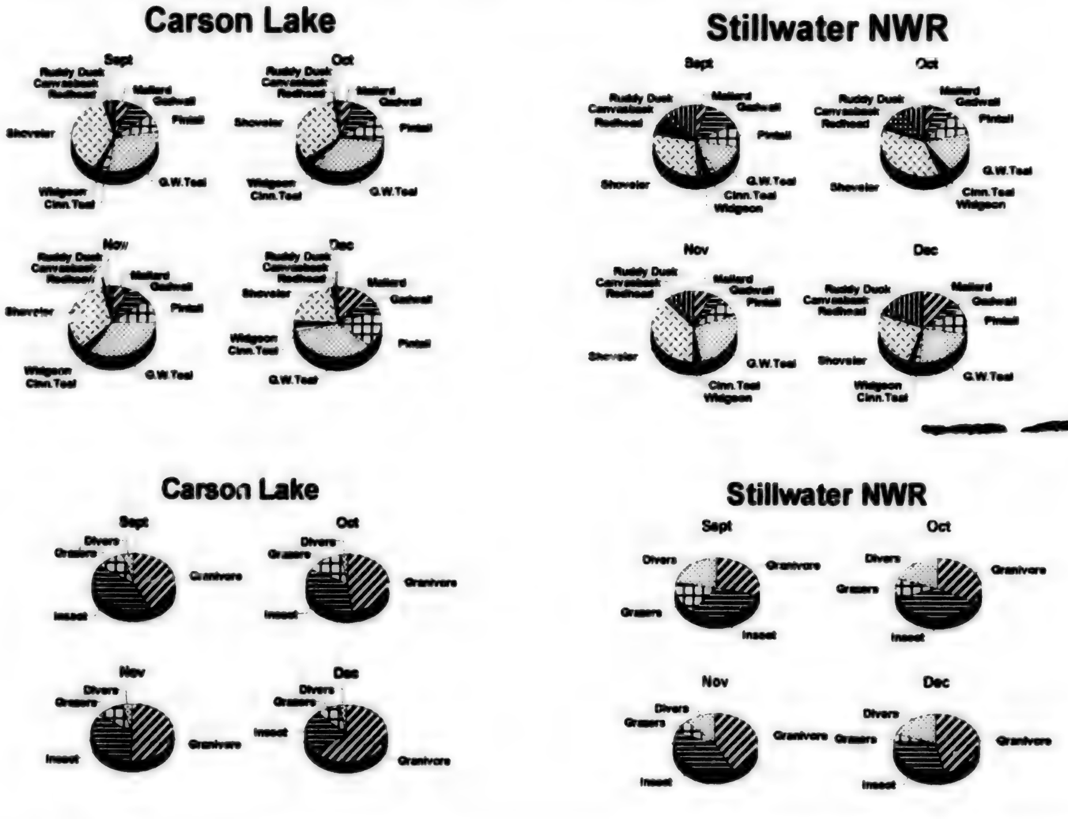
through the remainder of fall and winter months (Fig. 12). The average peak for Stillwater NWR and Carson Lake combined is 114,380 (October) with Stillwater NWR holding approximately 75% (85,179) of this total. Carson Lake does, however, maintain similar to slightly higher spring populations which results in higher duck densities when considering that Stillwater typically has more wetland acres during spring. Species composition is somewhat different between the two areas, with Carson Lake populated by proportionally more dabbling ducks and Stillwater Marsh receiving the higher proportion of diving duck use. These trends are further displayed by observing waterfowl foraging guild preferences during the fall months (September - December; Fig. 13).

Figure 13: A comparison of species specific and foraging guild composition between Carson Lake and Stillwater NWR during fall (Sept.-Dec., 1970-98).



Dabbling ducks comprise 95-98% of the Carson Lake total while diving ducks range from 12-22% of the Stillwater total. Primary species at each site are similar with northern shoveler, green-winged teal, and northern pintail dominant in fall counts; however a more equal percentage of the various dabbling duck species appears to occur at Stillwater NWR. When species composition is considered relative to seasonal requirements and forage/habitat type preferences, this difference becomes even more apparent.

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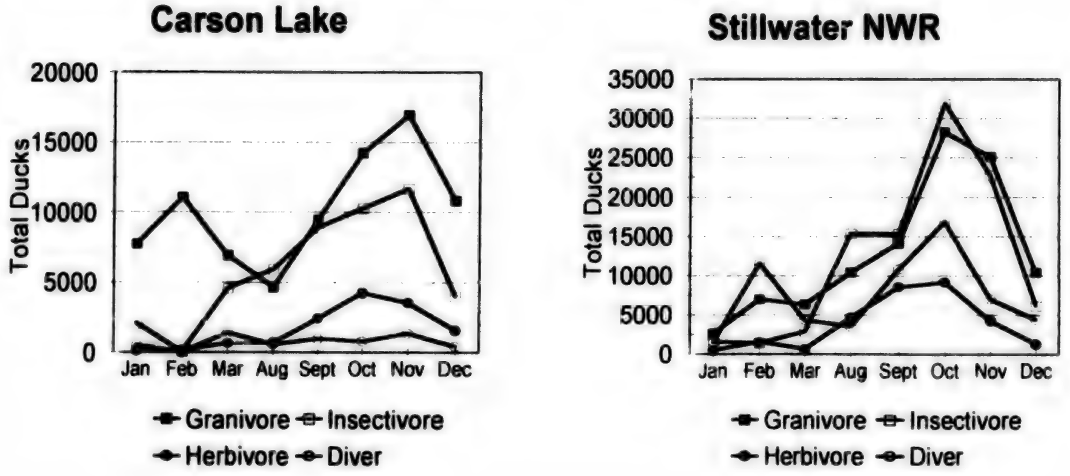
To examine forage preferences, species were placed into four specific foraging guilds based on feeding ecology research for the species present in the Lahontan Valley. While this research was not conducted in the Lahontan Valley, and many of the species considered are opportunistic and can easily adapt to a variety of habitats, four guilds were subjectively selected to represent the preferred habitat and forage items for the species during migration periods (Bellrose 1982). Selected guilds are granivores (mallard, northern pintail, green-winged teal), insectivores (northern shoveler, cinnamon teal), herbivores (American wigeon, gadwall), and diving ducks (redhead, canvasback, and ruddy ducks). Cinnamon teal appear to be more granivorous throughout their life history cycle; however, it is believed that aquatic invertebrates comprise a large percentage of their diet during the August - September peak use period in Lahontan Valley and they are often observed foraging in similar habitats as northern shoveler during early fall. Piscivorous species such as the common merganser display a strong preference for Stillwater NWR habitats; however, peak counts only average near 1,000 total birds (December and January) and, therefore, are not considered in this analysis.

Granivorous species comprised 43-64% of the Carson Lake total (compared to 29-47% of the Stillwater NWR total) with insectivores (24-41%), herbivores (9-14%), and divers (3-4%), rounding out the Carson Lake duck population during fall. Conversely, a more even distribution among foraging guilds is apparent for Stillwater NWR with granivores (29-47%), insectivores 28-38%), divers (12-22%), and grazers (6-18%) nearly equal during September. Grazers tend to drop off from October through December at Stillwater NWR, possibly shifting to Carson Lake habitats where grazers are well represented throughout fall months.

Fewer data are available for a spring analysis; however, Carson Lake population totals appear to be similar to slightly higher than Stillwater NWR. Carson Lake is strongly dominated by dabbling ducks (nearly 99%) during February, with March numbers depicting a more

Figure 14: Monthly average duck population by foraging guild for Carson lake and Stillwater NWR (Aug. - Mar., 1970-98).



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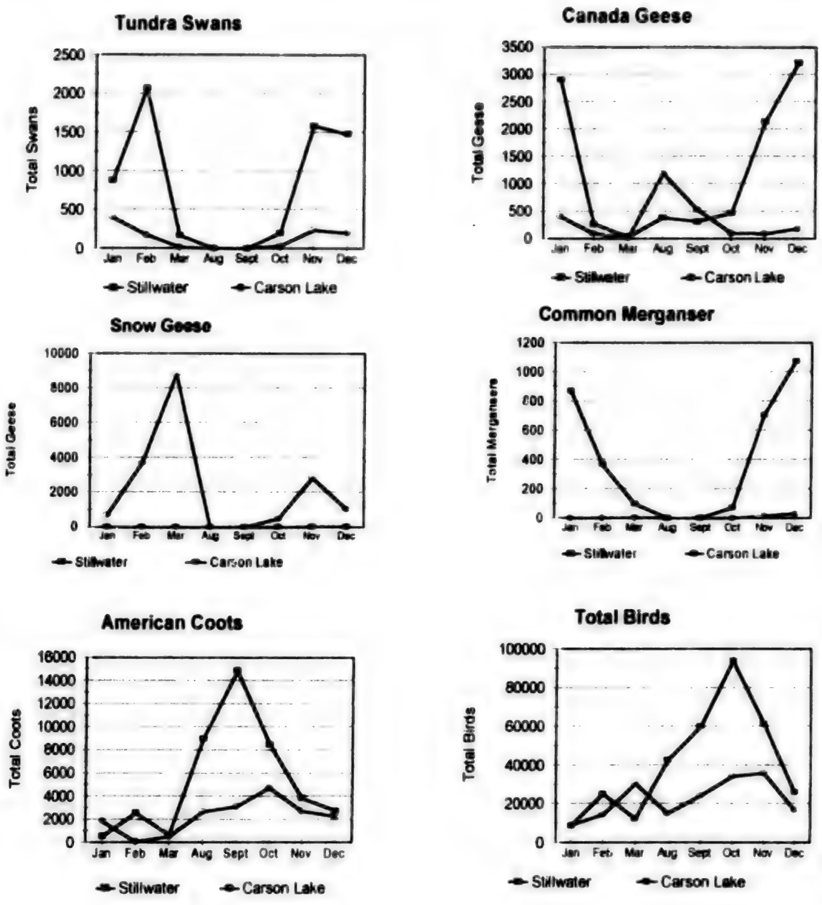
proportional mix among foraging guilds (Fig. 14). As will be considered in the discussion section, these differences are likely related to the different habitats provided at Stillwater NWR and Carson Lake during spring.

Figure 15: Monthly average, non-duck species population for Carson Lake and Stillwater NWR (Aug - Mar, 1970-98)



Tundra swans, common mergansers, and American coots, all experience higher populations at Stillwater NWR throughout the year, with mergansers almost exclusively found at the Stillwater marsh (figure 15). Geese display a differential response with snow geese inhabiting Carson Lake in much higher numbers while the distribution of Canada geese appears to change seasonally. The Carson Lake Canada goose population rises to nearly 1,200 birds in March; however, Stillwater populations remain disproportionately higher during fall and winter months. In all cases, these differences would seem closely related to differences in habitats provided at the two areas,

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Stillwater NWR Wetland Unit Analysis

Individual wetland units within the Stillwater NWR experience waterfowl use patterns likely related to habitat availability, disturbance, and hydration. Certain species tend to concentrate in specific units which is related to species specific, seasonal and diurnal life history requirements each unit can fulfill. These unit characteristics are a function of unit size, amount of unit hydrated, hydration timing, and related vegetative response which appears to vary both annually and seasonally within units. Rather than cover each year individually, table 2 examines the average monthly wetland acreage for available years between 1977 - 98, for seven sanctuary and seven non-sanctuary units.

The full pool acreage is included at the top of each column followed by the monthly average for each wetland unit. Total wetland acreage by sanctuary designation is provided in the final column

Table 2: Average monthly acreage among 14 wetland units at Stillwater NWR, 1977-98.

Sanctuary Units	Cattail Lake	Division Pond	Dry Lake	East Alkali Lake	Lower Foxtail	Stillwater Point	Upper Foxtail Lake	Total
	270	100	565	585	1,190	1,840	370	4,920
Jan	213	53	539	424	1121	985	296	**3631**
Feb	208	33	459	361	883	1196	170	**3309**
Mar	194	25	400	333	904	1104	192	**3153**
Apr	180	39	352	251	799	941	241	**2802**
Aug	227	24	517	345	1170	1119	296	**3698**
Sept	195	37	464	340	1090	1123	263	**3512**
Oct	226	38	489	406	1139	1069	259	**3626**
Nov	210	45	472	427	1135	980	249	**3517**
Dec	199	27	521	394	1127	1275	213	**3755**
Average	**206**	**36**	**468**	**365**	**1041**	**1088**	**242**	**3445**

Non-sanctuary Units	Goose	Lead Lake	Nutgrass	Pintail Bay	Swan Lake	Tule Lake	West Marsh	Total
	1,006	1,025	3,495	1,520	1,880	1,245	2,830	13,001
Jan	902	930	3175	1241	1776	1152	1868	**11043**
Feb	834	827	3146	1463	1451	1195	2123	**11038**
Mar	936	943	2936	1444	1340	1198	566	**9362**
Apr	855	849	2427	1127	1316	898	1238	**8711**
Aug	917	844	2609	1025	940	956	1421	**8713**
Sept	895	871	2651	979	940	930	1505	**8771**
Oct	942	829	2903	853	918	771	1236	**8453**
Nov	926	868	2894	845	1135	795	1403	**8867**
Dec	971	905	3099	909	1310	926	1258	**9378**
Average	**909**	**874**	**2871**	**1098**	**1236**	**980**	**1402**	**9371**

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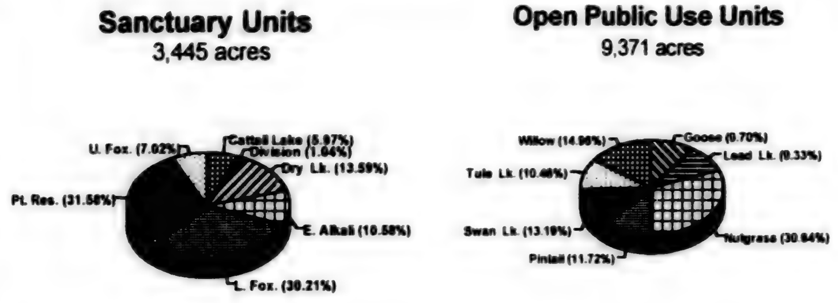
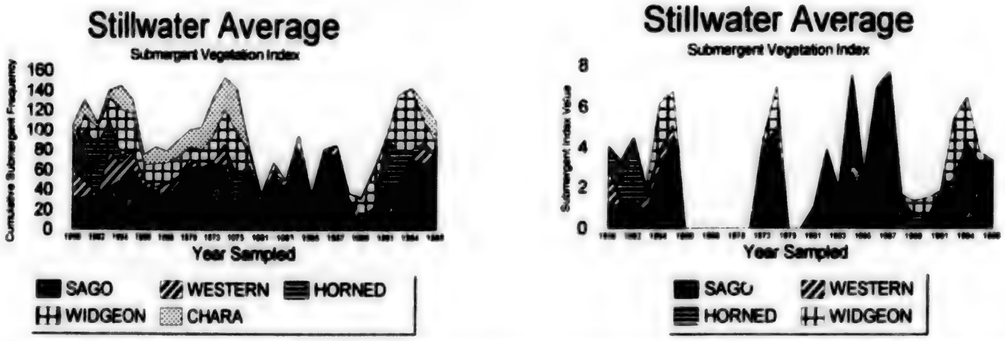
allowing for an analysis of the percentage of each area a specific wetland unit occupies (figure 16). For example, Cattail Lake has a full pool estimated at 270 acres. Across years where this unit was hydrated, seasonal acreage ranged from 180 ac. (April) to 227 ac. (August), comprising roughly 6% of the sanctuary wetland acreage base. Each unit was hydrated a different number of years and only those years where hydration occurred were used in this analysis. On average, 70% of sanctuary units and 72% of open public use units have been hydrated, with seasonal peaks typically occurring during winter (Dec. - Feb.). Unit specific peaks vary by refuge location, with most northern units (non-sanctuary) displaying winter peaks and southern units (sanctuary) experiencing peak acreage during different time periods.

Figure 16: Relative size of wetland units within sanctuary and open public use areas at Stillwater NWR, 1977-98.



Frequency of occurrence among submergent vegetation species common to Stillwater NWR wetland units were also analyzed to help elucidate waterfowl, species specific, seasonal use

Figure 17: Frequency and density index for submergent vegetation species common to Stillwater NWR wetland units.



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patterns (figure 17). The left figure encompasses the frequency at which each species was sampled while the right figure is an index created to examine the combination of sampling frequency and density. Density values were not recorded for all years, but where available, the following calculation was used to create an index of submergent vegetation availability:

(Species frequency * Species density) / 1000 = Submergent vegetation index

As displayed, sago pondweed (*Potamogeton pectinatus*), is the primary species found throughout wetland units and years, with western pondweed (*Potamogeton latifolia*), horned pondweed (*Zanichellia pallustris*), wigeongrass (*Ruppia maritima*), and muskgrass (*Chara* sp.), together comprising more than 98% of the total. A general trend with sago pondweed strongly dominating southern wetland units and a more even species mix on northern wetland units was documented, with availability of the various submergent species likely contributing to the proportional mix of waterfowl species populating each unit. The following discussion, will examine vegetation response and waterfowl species use relative to the different hydration schedules calculated for all units on Stillwater NWR.

Sanctuary Wetland Units

Cattail Lake

Table 3: Duck species numbers by month in Cattail Lake, 1970-98.

Month	Mallard	Gadwall	Pintail	G.W.Teal	Cinn.Teal	Wigeon	Shoveler	Redhead	Canvasback	Ruddy Duck	Total
Jan	15	5	114	90	0	30	0	20	27	30	331
Feb	34	20	169	320	30	100	75	25	145	90	1008
Mar	13	30	333	160	13	20	110	20	25	55	778
Apr	44	26	22	64	19	0	113	38	10	60	396
Aug	113	572	359	204	135	139	613	79	20	53	2286
Sept	123	537	384	399	92	270	670	748	233	293	3748
Oct	123	361	289	1388	250	369	1534	220	454	224	5211
Nov	144	208	175	518	0	194	353	25	416	180	2214
Dec	41	343	194	378	15	177	361	20	32	113	1675

Cattail Lake is a small wetland unit (270 acres at full pool) located at the northern end of the Stillwater NWR sanctuary area (south of Division Rd.). Early during fall, duck species composition is fairly well split among the primary 10 species, with Northern shoveler, redhead, canvasback, and green-winged teal comprising the highest proportional use of the unit during later fall and winter months (table 3; figure 18). Herbivorous and granivorous species are strongly dominant during fall with granivorous species (primarily northern pintail and green-winged teal) having higher compositions during spring. Total duck density reaches a peak of 23.1 ducks/ac during October and averages greater than 10 ducks/ac. From August - November. Spring densities range from 2.3 to 4.8 ducks/ac.

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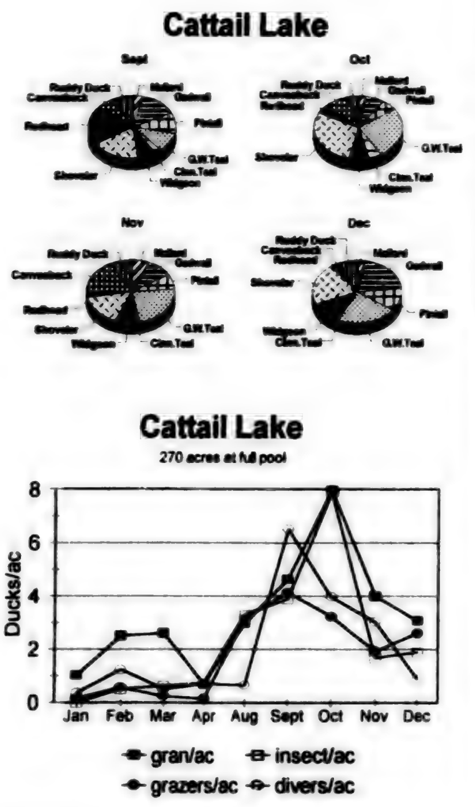
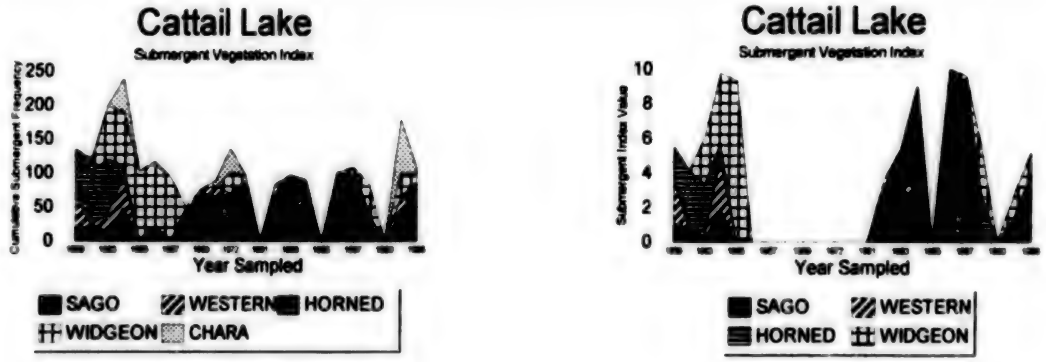
Figure 18: Duck species composition and foraging guild density for Cattail Lake, 1970-98.



Wetland acreage ranged from 180 ac. (April) to a high of 227 ac. (August) providing a seasonal proportion of the unit flooded of 67% and 84%, respectively. This relatively consistent flooding provided perennial water conditions, suitable for sustaining submergent vegetation (figure 19). From 1959 to present, Cattail Lake had an average depth of 30 cm., a salinity range of 1371 to 3205 ppm (2033 average), and a turbidity average of 17 cm over the 23 years of submergent vegetation sampling. Sampling frequency for the five most common submergent vegetation species averaged 46% (sago pondweed), 8% (western pondweed), 12% (horned pondweed), 26% (wigeongrass), and 8% (muskgrass) with submergent index values of 2.00, 0.27, 0.52, and 0.94 for the first four species. Annual variation was significant, with index values ranging from 0 (1985) to 9.216 (1987) for sago pondweed which was the dominant submergent vegetative species in Cattail Lake throughout the 1980's and 90's.

Figure 19: Submergent vegetation availability by frequency and density in Cattail Lake, 1959-96.



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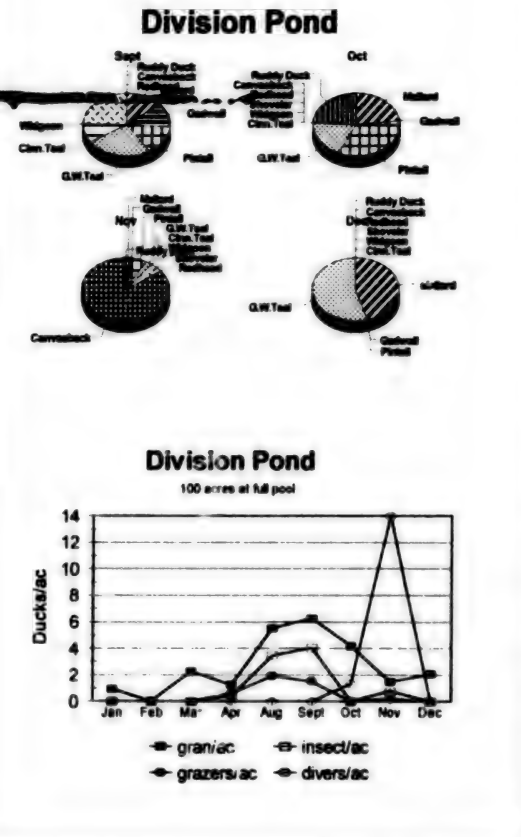
Division Pond

Table 4: Duck species numbers by month in Division Pond, 1970-98.

Month	Mallar	Gadwa	Pinta	G.W.Tea	Cinn.Te	Wigeon	Shovele	Redhea	Canvasba	Ruddy Duc	Tota
Jan	10	0	40	0	0	0	0	0	0	0	50
Feb	1	0	0	0	0	0	0	0	0	0	1
Mar	0	0	30	27	0	0	0	0	0	0	57
Apr	30	23	0	20	17	0	0	0	0	0	90
Aug	28	48	98	10	55	0	30	0	0	0	268
Sept	58	55	65	106	41	0	108	0	0	0	433
Oct	48	0	70	40	0	0	0	0	0	50	208
Nov	10	10	37	20	0	0	35	0	630	0	742
Dec	25	0	0	30	0	0	0	0	0	0	55

Figure 20: Duck species composition and foraging guild density for Division Pond, 1970-98.



Similar to Cattail Lake, Division Pond is also a small (100 ac), shallow wetland located at the north end of the Stillwater NWR sanctuary. This unit was infrequently hydrated during the 1970-98 survey period with samples collected sporadically over 16 years (46 of 325 survey sessions), typically September through January (table 4; figure 20). Duck use was inconsistent in this unit with a different species dominant during each month. The 630 canvasback sampled during November is a result of only one November observation collected during the sampling period. Therefore, insufficient samples prevented a more detailed analysis of duck use in Division Pond. Duck density ranged from <1 bird/ac (February) to 16.5 birds/acre relative to the single November count.

Few submergent vegetation samples were collected in Division Pond as well, with data available for only four years between 1959 - 1996 (figure 21). Water depth averaged 17 cm, with salinity ranging from 716 - 1600 ppm. Water turbidity measurements averaged clarity to the bottom of the unit. Submergent vegetation sampling frequency was low with wigeongrass dominant in all years. When sampled, wigeongrass had a high submergent vegetation index value; however,

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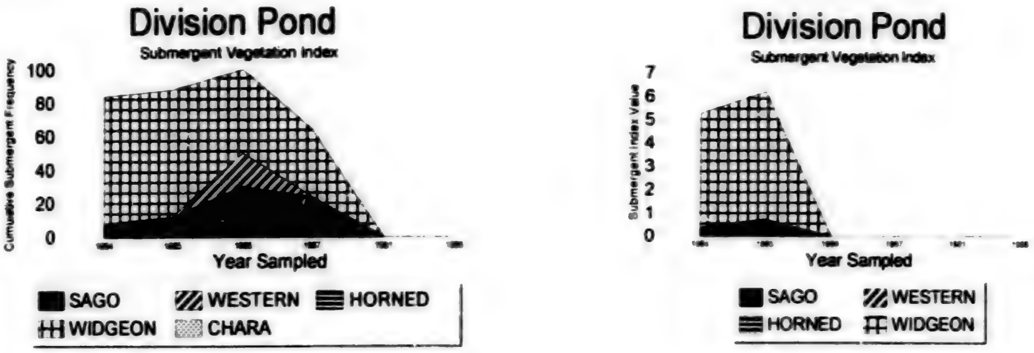
Figure 21: Submergent vegetation availability by frequency and density in Division Pond, 1959-96.



submergent vegetation comprised a small percentage of this units overall vegetative composition as confirmed by the relatively low frequency values (figure 21, first inset)

Dry Lake

For the purposes of the waterfowl discussion, east and west dry lakes are considered as one unit. Together, they encompass 565 acres at full pool and have traditionally maintained high acreage throughout flood and drought periods (table 2; 352-539 ac). Proportional duck use is fairly even among the 10 most common species through September; however, dabbling ducks including mallards, green-winged teal, and northern shoveler become more abundant during hunting season months. Diving ducks are equally abundant during hunting season with high canvasback populations typically recorded through November (figure 22). Overall duck density ranged from 2.7 birds/ac (April) to 28.5 birds/ac (October) with September through December retaining the highest density. Diving ducks experience peak density during spring and again in fall, related to

Table 5: Duck species numbers by month in Dry Lake, 1970-98.

Month	Mallard	Gadwall	Pintail	G.W.Teal	Cinn.Teal	Wigeon	Shoveler	Redhead	Canvasback	Ruddy Duck	Total
Jan	359	15	258	297	0	112	270	15	207	476	2008
Feb	189	26	287	188	70	27	50	34	169	1131	2170
Mar	43	50	308	324	39	31	170	54	288	1633	2938
Apr	22	61	19	97	31	25	50	55	71	394	825
Aug	264	196	311	142	206	61	252	147	89	239	1907
Sept	264	680	418	416	132	911	602	464	412	611	4910
Oct	749	739	965	3487	130	1021	2609	208	2835	925	13668
Nov	426	317	513	1202	20	444	1279	50	1582	623	6455
Dec	615	133	[illegible]	718	50	74	537	124	472	356	3385

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ruddy duck and canvasback numbers, respectively. All foraging guilds experienced peak density during October.

As stated, Dry Lake is a composite of two separate units (east and west) with the eastern unit dominated by emergent vegetation (providing thermal protection for wintering waterfowl), and the western unit dominated by thick submergent growth. While sago pondweed is the most common and productive among submergent species in the West Dry unit, western pondweed, horned pondweed, wigeongrass, and chara are all present during different years (Figure 23). In general, West Dry Lake averaged 43 cm in depth, maintained salinity levels between 1022 and 4075 ppm (1781 ppm avg.), and typically remained clear to the unit bottom. Over 28 years where submergent vegetation was sampled, only 16% of the transect points monitored did not produce submergent vegetation. Sago pondweed produced an average index of 3.22 across all years with a high of 10 recorded in 1995.

Figure 22: Duck species composition and foraging guild density for Dry Lake, 1970-98.

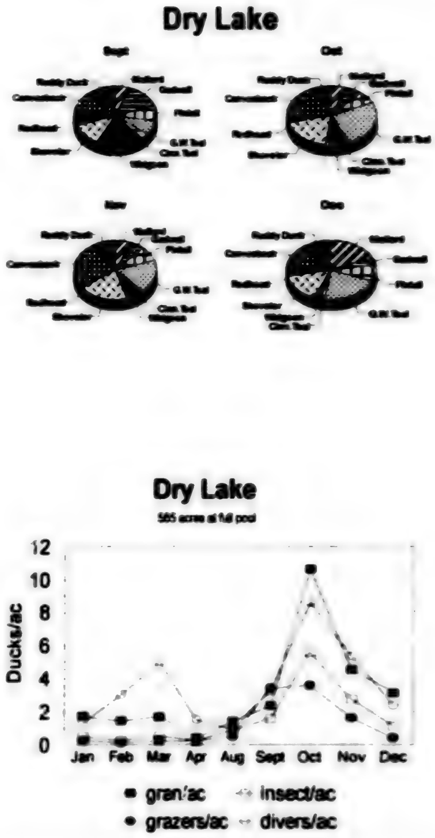
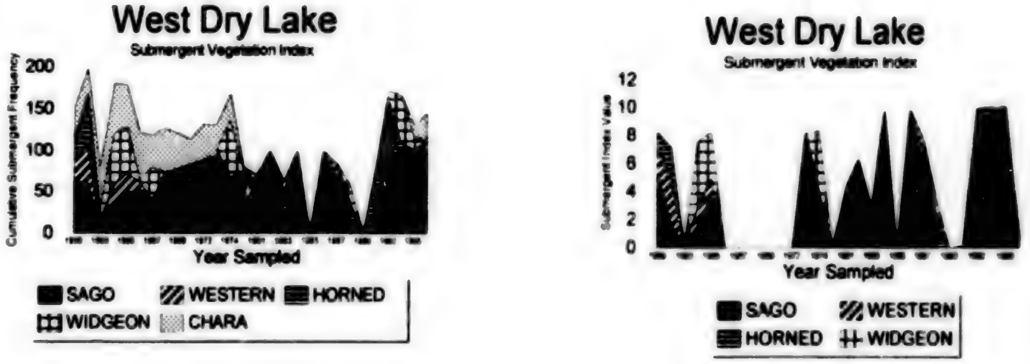


Figure 23: Submergent vegetation availability by frequency and density in Dry Lake, 1959-96.



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East Alkali Lake

Table 6: Duck species numbers by month in East Alkali Lake, 1970-98.

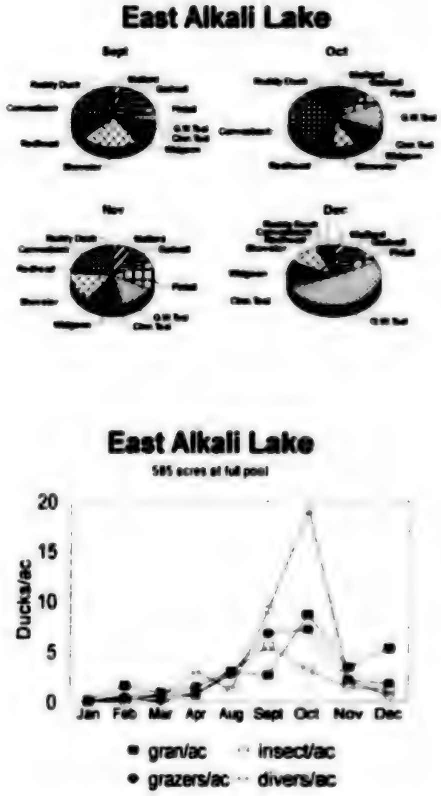
Month	Mallard	Gadwal	Pintail	G.W.Teal	Cinn.Teal	Wigeon	Shoveler	Redhead	Canvasback	Ruddy Duck	Total
Jan	50	0	25	0	0	0	0	0	0	0	75
Feb	69	25	380	108	0	90	40	65	50	40	867
Mar	26	25	82	174	37	8	170	28	58	100	708
Apr	29	114	50	283	27	75	148	71	10	660	1466
Aug	235	733	492	310	218	225	829	94	55	240	3431
Sept	270	1335	276	341	75	979	1825	974	763	1320	8158
Oct	303	1308	1078	2136	67	1610	1200	1078	4793	1575	15149
Nov	319	370	592	547	0	551	628	135	591	200	3932
Dec	130	270	193	1750	50	427	388	53	40	120	3419

East Alkali Lake is a 585 acre, shallow wetland, created in an historic alkali flat receiving water from precipitation or back fill from the Carson Sink. This unit has received freshwater input over the past 50 years which has led to considerable vegetative productivity and resulting waterfowl use (Table 6). All ten primary duck species are well represented on this unit; however, it appears to be particularly important during September and October for diving ducks and other herbivorous species. Green-winged teal tend to be the most abundant species during December, with respectable numbers from all other species recorded as well (figure 24).

While all foraging guilds were observed at low density during spring, this unit experienced high diving duck use (19 divers/ac) during October, and then granivorous species use from October through December (3.4 - 8.6 granivores/ac). Insectivorous species increased up to a September/October peak, and then, similar to grazing species, dropped significantly from October - December. Considering density, East Alkali Lake has consistently been the preferred wetland unit for fall canvasback use.

One reason for this is that submergent vegetation production has been excellent over the 14 years samples have been collected; particularly for sago pondweed and wigeongrass (figure 25). Unit

Figure 24: Duck species composition and foraging guild density for East Alkali Lake, 1970-98.



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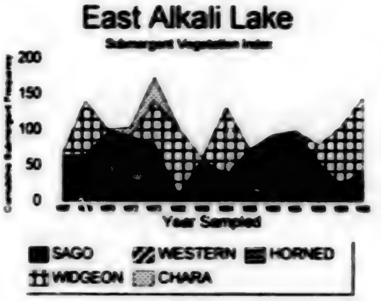
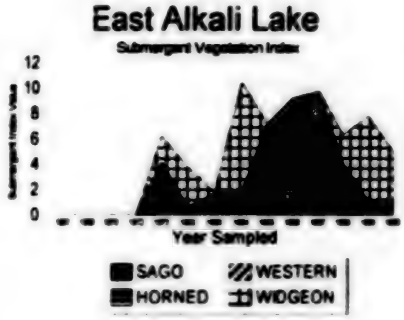
water depth has averaged 41 cm, salinity ranged between 1246 and 8537 ppm (4972 ppm average), and turbidity has remained relatively low (clarity to 29 cm) producing ideal conditions for submergent vegetation growth. Additionally, this unit has maintained perennial water throughout the year averaging between 251 (April) and 427 ac (November), providing late spring drawdown for germination of sago pondweed. The sago pondweed index has remained high, compared to most units and years with a high of 9.405 recorded in 1987 and an average of 2.89 over the observation period. Wigeongrass has also been consistent with a high of 8.74 recorded in 1984 and an average of 1.9. While western pond weed has been sampled on this wetland unit, only chara was sampled with any frequency, and then, only from 1970-73. Among wetland units analyzed during this effort, acre for acre, East Alkali Lake would appear to be the most important unit on Stillwater NWR for fall migratory waterfowl.

Figure 25: Submergent vegetation availability by frequency and density in East Alkali Lake, 1959-96.





Lower Foxtail Lake

As far as total birds are concerned, Lower Foxtail Lake (1,190 ac at full pool) holds the largest percentage of birds among Stillwater NWR wetland units (table 7). Similar to East Alkali Lake, an equal composition of duck species has been maintained during August and September;

Table 7: Duck species numbers by month in Lower Foxtail Lake, 1970-98.

Month	Mallard	Gadwall	Pintail	G.W Teal	Cinn Teal	Wigeon	Shoveler	Redhead	Canvasback	Ruddy Duck	Total
Jan	623	47	366	945	0	77	292	20	368	142	2878
Feb	188	109	657	683	40	30	1257	23	319	1020	4325
Mar	97	31	416	362	29	20	183	40	592	[illegible]	3137
Apr	35	139	37	215	74	30	189	46	138	845	1749
Aug	498	1185	886	384	154	231	1592	738	70	113	[illegible]
Sept	409	1687	997	622	198	1205	2951	1060	739	773	[illegible]
Oct	762	1858	3436	3143	131	3362	5631	524	7636	976	27458
Nov	944	644	2015	5338	25	841	4073	214	3783	1081	18958
Dec	735	230	1238	3252	403	248	1803	125	858	751	9642

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however, this unit became increasingly important for green-winged teal and canvasback as the hunting season progressed (figure 26). Diving ducks (canvasback in particular), were present in the highest density, but were closely followed by granivores, insectivores and grazers. Granivorous species increased through November and maintained their highest density from November through January. Total duck density on this unit ranged from 24.2, 16.8, and 8.6 ducks/ac for October - December, respectively.

Submergent vegetation production would be considered excellent, in Lower Foxtail Lake with sago pondweed and western pondweed both well represented throughout most of the 25 years this unit was sampled (figure 27). Production indices during the early to mid 1970's were the highest recorded for Stillwater NWR with a sago index of 8.0 and a western index of 3.75 recorded in 1973. Over the years, sago had an average index value of 3.04, maintained by a frequency and density of 63.7% and 44.8%, respectively. Horned pondweed, wigeongrass, and chara have also been well represented over the years with the former two species dominating submergent vegetation communities during early sampling periods.

Figure 26: Duck species composition and foraging guild density for Lower Foxtail Lake, 1970-98.

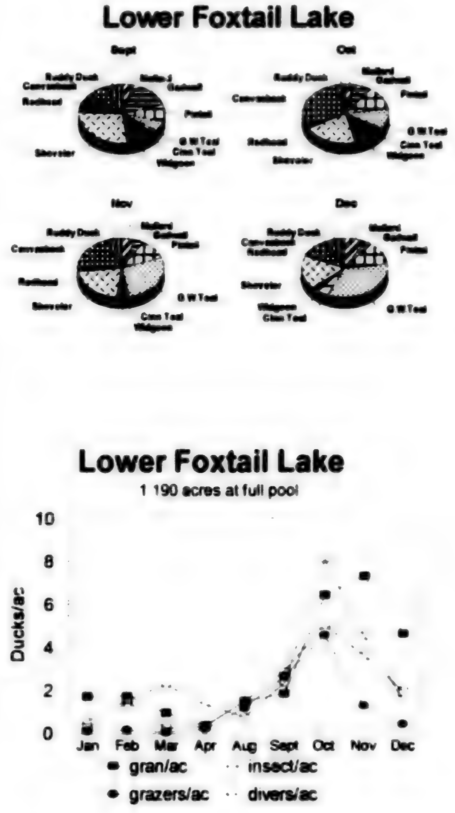
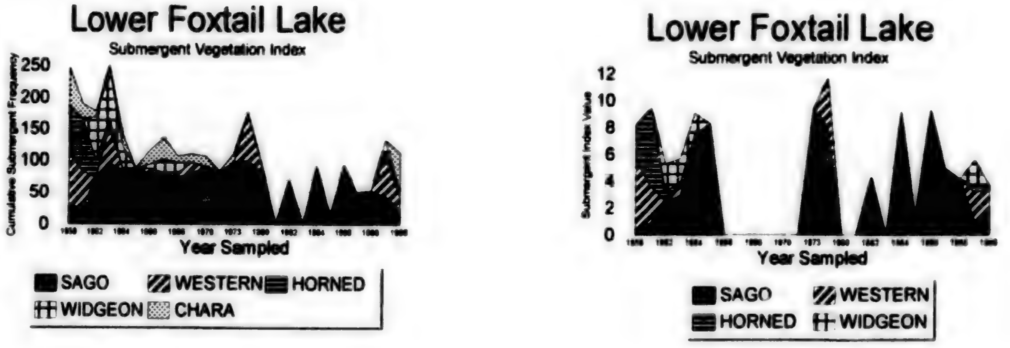


Figure 27: Submergent vegetation availability by frequency and density in Lower Foxtail Lake, 1959-96.



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The quality of submergent vegetation produced, and resulting waterfowl use, is likely the result of water management strategies implemented on this unit over time. Lower Foxtail Lake has been consistently flooded from 67% (April, 800 ac) to 98% (August, 1170 ac) of full pool with an average depth of 47 cm occurring at high water in August. Salinity ranged from 943 ppm to 3920 ppm, while water remained clear to 26 cm. Overall, these are optimal conditions for the production of sago pondweed (Kantrud 1990), which is displayed in the preceding figures. While East Alkali Lake has likely been the most important wetland unit for fall migratory waterfowl on an acre for acre basis, Lower Foxtail Lake has hosted the largest population of ducks during fall migration (average of 24,552 and 15,269 in October and November, respectively).

Stillwater Point Reservoir

Table 8: Duck species numbers by month in Stillwater Point Reservoir, 1970-98.

Month	Mallar	Gadwal	Pintai	G.W.Tea	Cinn.Tea	Wigeon	Shovele	Redhea	Canvasbac	Ruddy Duc	Total
Jan	209	40	98	977	0	10	37	0	50	90	1510
Feb	106	20	622	273	30	125	13	80	13	440	1722
Mar	68	20	336	254	30	33	93	46	156	474	1509
Apr	34	48	56	424	59	13	153	35	73	555	1451
Aug	135	109	224	160	240	100	455	132	460	81	2095
Sept	359	705	403	705	141	399	698	171	226	345	4154
Oct	1058	351	981	1617	58	359	1739	393	976	456	7989
Nov	1345	159	533	2594	50	131	459	141	561	291	6263
Dec	861	177	250	1338	145	62	441	68	664	838	484

Stillwater Point Reservoir, as the name implies, has primarily been used as a storage reservoir for hydration of lower units in the Stillwater marsh. As a result, this 1,840 ac wetland unit has ranged from 51% to 69% of full pool (940 to 1275 ac) with considerable variation occurring during the annual cycle. Duck use would be considered low as compared to other sanctuary wetland units, but similar to these other units, species composition was fairly equal during August and September. Mallard, and green-winged teal numbers steadily increased from October through November with a higher proportion of granivorous species occurring in this unit during October through December (table 8; figure 28). While water level fluctuation is optimal for annual seed production, which granivorous species rely on during late fall/winter months, it is uncertain whether this proportional increase was due to vegetation, or whether this unit was used as a staging point to access nearby agricultural fields for grain. An average of 1129, 928, and 706 Canada geese used this unit for the latter purpose from November through January. Canvasback use was highest from October through December with an average of 976 canvasback occupying Stillwater Point Reservoir during October. Maximum birds per acre (7.5) occurred in October, with granivorous species strongly dominant in this unit during October and November.

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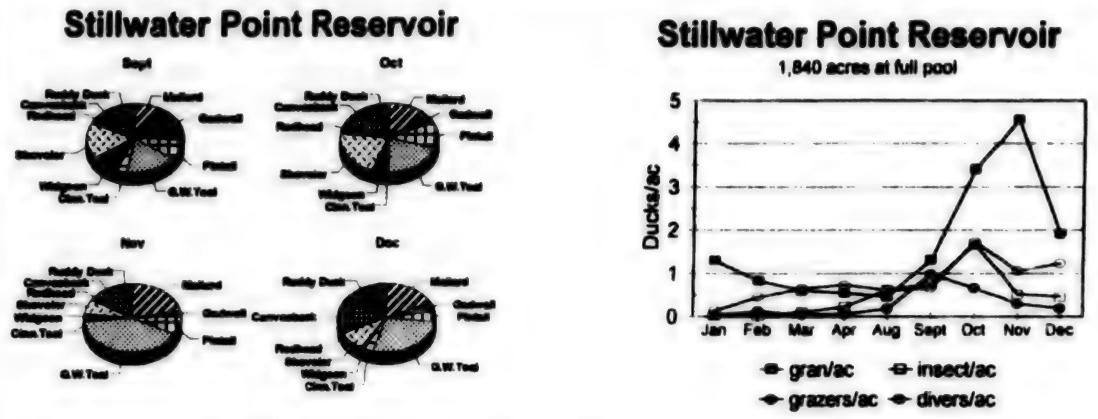
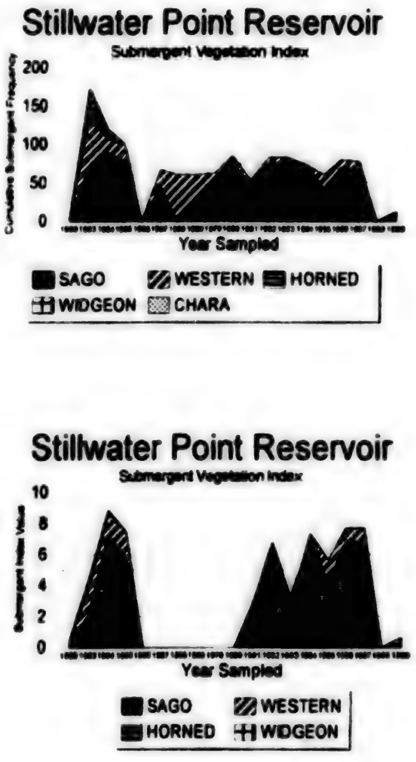
Figure 28: Duck species composition and foraging guild density for Stillwater Point Reservoir, 1970-98.



Submergent vegetation production was somewhat lower than comparable refuge units with low density and frequency recorded for sago pondweed, western pondweed, and horned pondweed (figure 29). As would be anticipated with fluctuating water levels, compounded by high flows through portions of the unit, submergent vegetation production was somewhat lower than other wetland units, with an average of 32% of transect points remaining unvegetated. Unit water depth averaged 52 cm over the 19 years this unit was sampled, while salinity ranged from 569ppm to 2063 ppm (1186 ppm average). Water clarity was good to 26 cm; however, clarity ranged from 8 cm to 1.1 m over the sampling period.

Even though sampling frequency was low, fair index values were recorded for both sago and western pondweeds where they occurred. Sago pondweed was sampled at an average index value of 2.77 (maximum of 6.42 in 1982) while western pondweed maintained an average index value of 0.49 (maximum of 1.73 in 1963).

Figure 29: Submergent vegetation availability by frequency and density in Stillwater Point Reservoir, 1959-96.



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Upper Foxtail Lake

Table 9: Duck species numbers by month in Upper Foxtail Lake, 1970-98.

Month	Mallar	Gadwal	Pintai	G.W.Tea	Cinn.Tea	Wigeon	Shovele	Redhea	Canvasbac	Ruddy Duc	Total
Jan	120	0	35	43	0	10	20	10	47	25	310
Feb	70	10	73	368	30	20	5	100	70	600	1346
Mar	18	9	120	51	36	0	18	18	10	80	360
Apr	25	39	15	140	33	6	62	23	30	158	531
Aug	86	101	71	93	84	15	103	42	0	10	606
Sept	143	152	82	281	39	114	78	64	85	40	1078
Oct	344	89	621	1303	40	63	191	378	273	84	3385
Nov	205	129	534	784	10	115	216	36	207	40	2276
Dec	118	55	223	205	0	50	82	10	120	25	888

Similar to Stillwater Point Reservoir, Upper Foxtail Lake is subject to seasonally high flows and considerable fluctuation in water level. This 370 acre unit has ranged from 170 ac (February) to 296 ac (January and August) which equates to 46-80% of full pool on a monthly basis. Divided into two separate units (Duff's Pond and Upper Foxtail Lake), each provides different habitat types with Duff's Pond (80 ac) typically occupied by submergent vegetation and Upper Foxtail (290) comprised of an emergent, moist-soil, and submergent vegetation mix. Waterfowl use varied accordingly with a disproportionate percentage of dabbling ducks (primarily mallards, gadwall, northern pintail, and green-winged teal) surveyed through fall months (table 9;figure 30). A more even mix of diving ducks and granivores occurred during spring with insectivores and grazers poorly represented throughout the annual cycle. Waterfowl density was relatively high through the hunting season with 13.1, 9.4, and 4.3 ducks/ac recorded from October through December. Within this total, 67%, 65%, and 60% consisted of granivorous species (mallard, green-winged teal or northern pintail.

Figure 30: Duck species composition and foraging guild density for Upper Foxtail Lake, 1970-98.

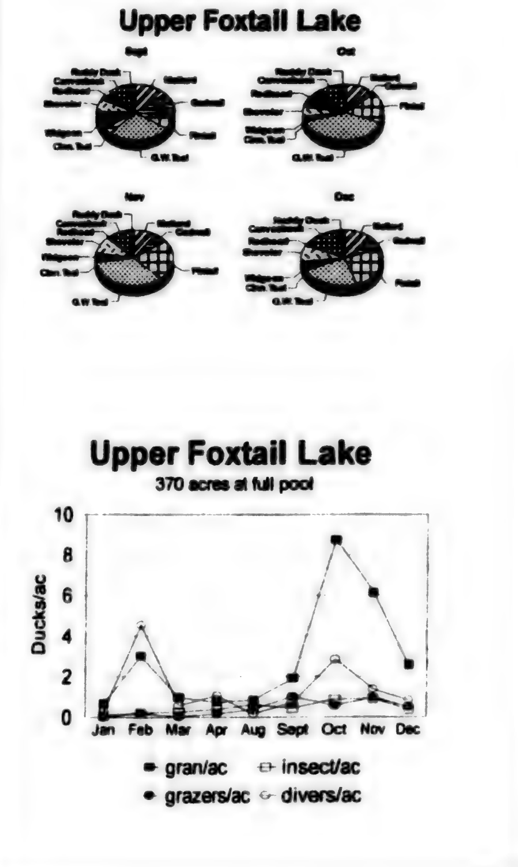

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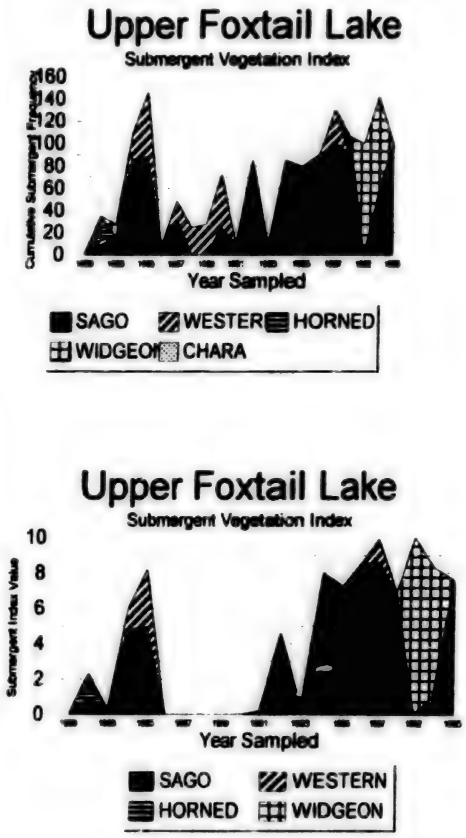
Figure 31: Submergent vegetation availability by frequency and density in Upper Foxtail Lake, 1959-96.



Submergent vegetation surveys were only conducted in Duff's Pond which covers 21% of the total Upper Foxtail area. This unit was comprised of sago, western, and horned pondweed's with significant dominance changes occurring at different points during the 21 years this unit was sampled. Index values alternated accordingly with horned pondweed dominant during early years (1959-62), sago pondweed during the middle period (1963-1991), and more recently, wigeongrass through the middle 1990's. Western pondweed was well represented during middle years but missing density values did not allow for calculation of an index value.

Duff's Pond had one of the deepest average water depths among Stillwater NWR wetland units (68 cm), and also maintained the lowest salinity range (1257 ppm to 2462 ppm; average of 1753 ppm). Water clarity was quite high at 26 cm; however, so was the percent of plots which did not contain submergent vegetation (38%). When characterizing Upper Foxtail Lake (and resulting waterfowl use), it should be understood that 79% of the unit consisted of vegetation other than submergent. It is possible that high water level fluctuations have produced a mix of early successional, seed-producing plants which would explain the disproportionately high granivorous species use throughout the sample period. Alternatively, this unit could be used as a staging point, similar to Stillwater Point Reservoir, based on proximity to agricultural lands.

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Non-Sanctuary Wetland Units

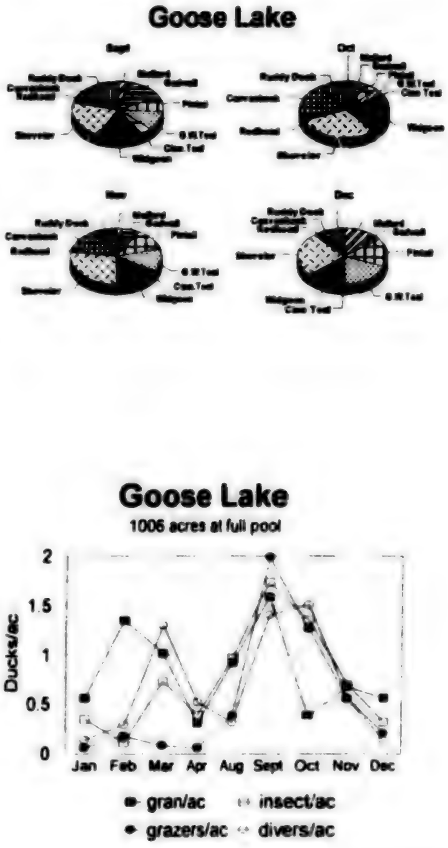
Goose Lake

Table 10: Duck species numbers by month in Goose Lake, 1970-98.

Month	Mallard	Gadwall	Pintail	G.W.Teal	Cinn.Teal	Wigeon	Shoveler	Redhead	Canvasback	Ruddy Duck	Total
Jan	137	17	141	223	10	35	305	30	45	50	994
Feb	88	23	630	406	35	125	56	44	127	70	1602
Mar	24	44	569	353	68	35	623	43	196	967	2921
Apr	29	38	39	197	42	14	290	39	81	304	1072
Aug	119	293	456	270	311	58	579	140	53	96	2373
Sept	221	822	539	656	244	958	1310	302	149	808	6008
Oct	43	282	169	153	65	910	1212	139	750	425	4148
Nov	34	152	281	311	0	362	649	18	307	188	2302
Dec	122	51	199	226	15	150	298	27	55	57	1199

Goose Lake is a 1,006 acre unit located in the center of the refuge. This unit is the first to receive water from the sanctuary wetland units, and can be hydrated or drained from several different points. Considering it's proximity to Stillwater NWR water sources, it has consistently maintained permanent water averaging approximately 90% of full pool (909 ac). Average seasonal acreage ranged from 834 ac (83% full pool, February) to 971 ac (97% full pool, December), providing one of the most consistently available units for duck use throughout the survey period.

Figure 32: Duck species composition and foraging guild density for Goose Lake, 1970-98.



Waterfowl use was variable with different species and guilds dominant through different months of the year (table 10; figure 32). As would be expected in a perennial unit, diving ducks and grazers were observed at higher densities through most months with granivore peak use occurring in February and then again in September. The overall waterfowl population peaked in September with hunting season apparently having an effect on species distribution. As with other units, September use was evenly split among a variety of species; however, use shifted to canvasback,

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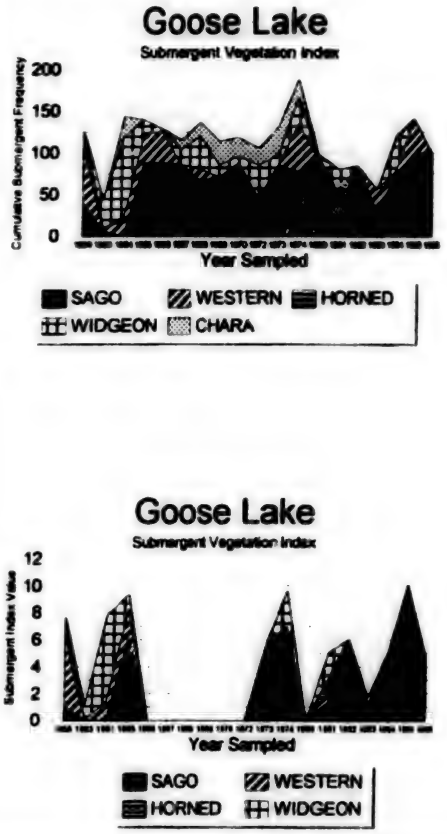
shovelers, wigeon, and ruddy ducks from October through December. Waterfowl density remained relatively low throughout the year with a peak density of 6.7 ducks/ac recorded in September (evenly split among foraging guilds), to a low 1.1 ducks/ac in January.

Considering low monthly variation in acreage, submergent vegetation production has remained high in this unit (figure 33). Sago pondweed has been the dominant submergent vegetation species throughout the 19 years this unit was sampled, with all other primary species well represented. Little variation in water depth (average 34 cm) and relatively low salinity (average 2706 ppm), has promoted extensive coverage by submergent vegetation. Goose Lake recorded one of the lowest unvegetated frequencies (12.6%) and few other species are present other than an emergent fringe around the shoreline and seasonally flooded saltgrass meadows. Average index values for sago pondweed ranged from 0.036 (1963) to 6.7 (1974), with an average value of 2.51 across all years. Other species index values were 0.54, 0.13, and 0.73 for western pondweed, horned pondweed, and wigeongrass, respectively.

Figure 33: Submergent vegetation availability by frequency and density in Goose Lake, 1959-96.



Lead Lake

Table 11: Duck species numbers by month in Lead Lake, 1970-98.

Month	Mallard	Gadwall	Pintail	G.W.Teal	Cinn.Teal	Wigeon	Shoveler	Redhead	Canvasback	Ruddy Duck	Total
Jan	35	127	40	1332	0	0	584	10	0	883	3010
Feb	91	42	263	450	17	20	457	78	255	553	2225
Mar	40	24	117	217	21	13	141	33	40	1025	1671
Apr	34	38	67	496	37	30	734	73	11	484	2004
Aug	31	86	106	457	307	10	615	50	0	41	1704
Sept	38	103	351	703	146	178	512	39	10	353	2433
Oct	32	73	327	553	25	144	896	30	40	168	2288
Nov	31	37	72	483	0	0	274	20	10	244	1176
Dec	41	32	26	129	0	0	256	0	0	241	725

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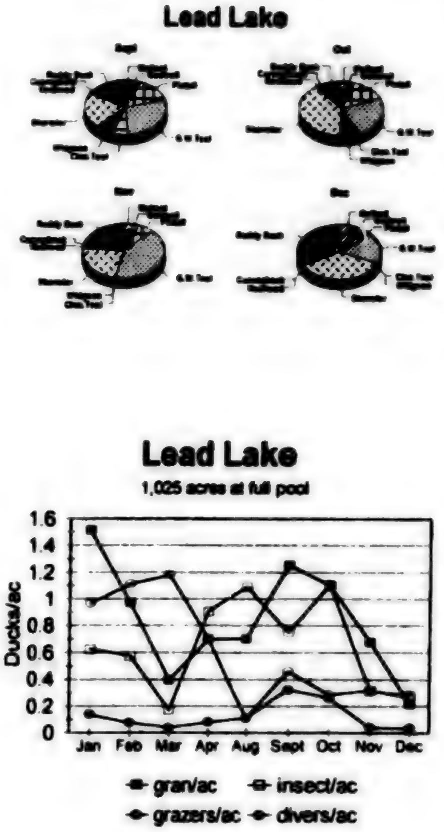
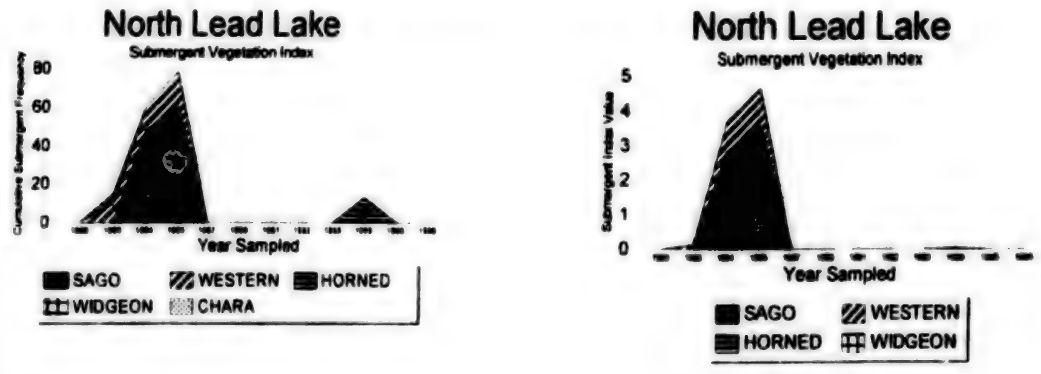
Duck numbers, as compared to other Stillwater NWR wetland units, were quite low in this 1,025 acre unit. Acreage ranged from 827 ac (81% full pool, February) to 943 ac (92% full pool, March) with little variability noted within or among years. Green-winged teal, northern shoveler, and ruddy ducks were the primary species using this wetland throughout the annual cycle with little change in species composition occurring during the hunting season (table 11, figure 34). Numbers tended to drop through the early and mid parts of the season; however, Lead Lake's peak duck count occurred in January, likely related to the depth and openness of the unit for wintering birds. Waterfowl density was also low with a high of 3.2 ducks/ac (January) and a low of 0.8 ducks/ac recorded in December. Foraging guild composition was dominated by granivores and insectivores from August - January (primarily related to green-winged teal and northern shoveler numbers); however, a shift towards diving ducks occurred during spring with a peak of 1.18 divers/ac recorded in March (83% ruddy ducks).

Figure 34: Duck species composition and foraging guild density for Lead Lake, 1970-98.



Low duck use was consistent with low frequency of submergent vegetation occurring in this unit over time (figure 35). During the 12 years this unit was sampled, no vegetation was encountered on transects 7 years with an average unvegetated frequency of 72.6%. Possible reasons for this

Figure 35: Submergent vegetation availability by frequency and density in Lead Lake, 1959-96.



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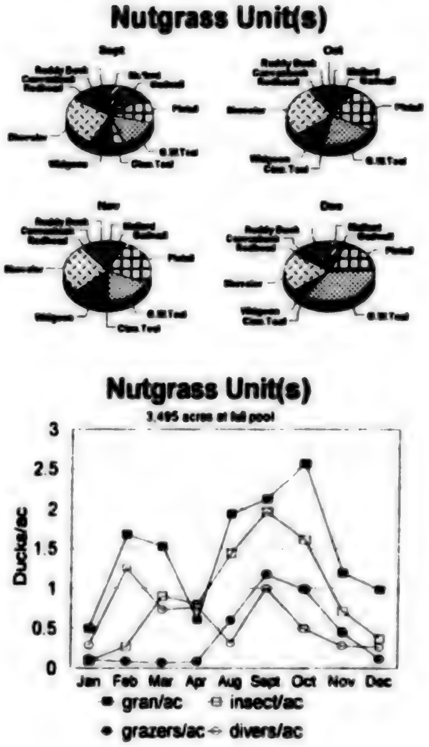
result include the high average depth (70 cm) combined with high water turbidity (clarity to 11 cm). Salinity ranged between 1335 ppm and 2178 ppm with an annual average of 1990 ppm. This salinity level is in the optimal ranges for both western and sago pondweeds (which dominated most samples); however, frequency and the submergent vegetation index were low throughout the sampling period with combined indices only reaching 2.1 on average. This unit was among the poorest for both waterfowl use and submergent vegetation production over the respective sampling periods.

Nutgrass Unit

Table 12: Duck species numbers by month in the Nutgrass units, 1970-98.

Month	Mallard	Gadwall	Pintail	G.W.Teal	Cinn Teal	Wigeon	Shoveler	Redhead	Canvasback	Ruddy Duck	Total
Jan	196	235	434	958	10	107	293	43	267	446	2989
Feb	303	80	2588	2380	68	186	796	183	830	2771	10185
Mar	113	100	2210	2160	431	112	2232	126	169	1831	9484
Apr	33	72	198	1259	228	128	1720	137	39	1574	5389
Aug	886	1221	2168	1989	1546	350	2215	347	70	398	11189
Sept	611	1777	2457	2550	685	1351	4534	1321	286	1014	16585
Oct	181	1224	4039	3226	177	1645	4505	651	427	332	16407
Nov	140	342	1924	1384	35	960	2044	148	290	343	7611
Dec	193	136	982	1877	24	215	1135	103	126	575	5365

Figure 36: Duck species composition and foraging guild density for the Nutgrass units, 1970-98.



As sampled during the waterfowl surveys, the Nutgrass unit is divided among the present, South, North, and West Nutgrass subunits. Combined, these subunits encompass 3,495 acres with average acreage ranging from 2,609 ac (75% full pool, August) to 3179 ac (91% full pool, January). Waterfowl use has been high over the years with an average total duck count ranging from 2,989 (January) to 16,585 (September; table 12). Species composition is comprised of all ten primary species during September, with northern shoveler, green-winged teal, and northern pintail most common (figure 36). This trend is fairly consistent throughout the annual cycle and October's peak count (occurring during hunting season in most years), is nearly identical to the September count.

Similar to other Stillwater NWR wetland units, species composition was fairly consistent among the 10 primary species in September. This trend shifted during hunting season with American

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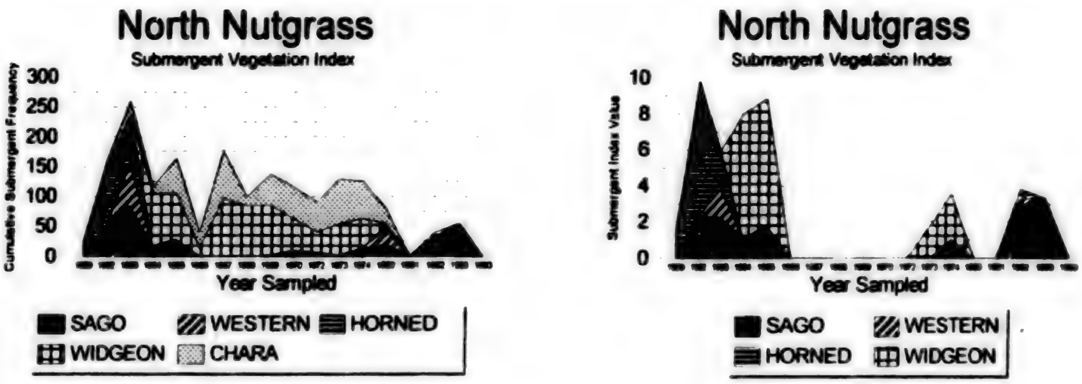
wigeon and ruddy ducks increasing proportionally from October through December. Overall density ranged from 6.3 ducks/ac (September) to 1 duck/ac (January) with granivorous species leading composition and density in all months but April. A bimodal peak density was noted for granivorous and diving duck species (February and September/October) while insectivores and grazers were much more common during fall months. The diving duck guild was strongly dominated by ruddy ducks, with canvasback encompassing a small percentage of overall use and redheads decreasing as hunting season progressed.

Submergent vegetation production was nearly even with the Stillwater NWR average, but species composition was much different than other units (figure 37). Over the 18 years this wetland unit was sampled, species dominance shifted among all five species. This makes perfect sense when you consider the average water depth (22 cm), the salinity range (3037 ppm to 26,890 ppm; average 7,723 ppm), and the fact that wide variation exists in wetland acreage over the growing season. During early years, lower salinity levels provided conditions suitable for establishment of sago, western, and horned pondweeds. As water became less available through the middle years, salinity increased and wigeongrass and chara became the dominant species. This trend has oscillated over time; however, all sample years were characterized by an average of 73% vegetative coverage among sample points. This produced average index values of 0.82, 0.17, 0.61, 0.67, and 1.36 for sago pondweed, western pondweed, horned pondweed, chara, and wigeongrass, respectively. While these averages were small, this resulted in an average submergent vegetation index value of 3.63 among all years. Overall, high duck use numbers and good submergent vegetation productions would rank this unit among the better non-sanctuary wetland units at Stillwater NWR.

Figure 37: Submergent vegetation availability by frequency and density in the Nutgrass units, 1959-96.



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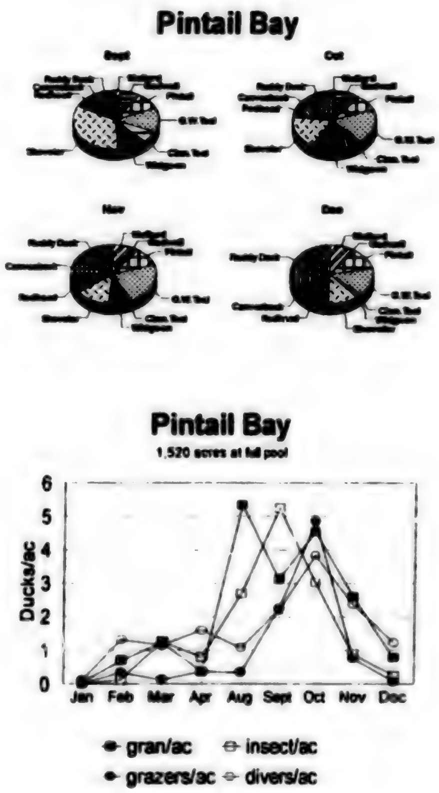
Pintail Bay

Table 13: Duck species numbers by month in Pintail Bay, 1970-98.

Month	Mallard	Gadwall	Pintail	G.W.Teal	Cinn.Teal	Wigeon	Shoveler	Redhead	Canvasback	Ruddy Duck	Total
Jan	0	0	60	0	0	0	0	70	5	60	195
Feb	33	295	738	254	22	197	148	419	219	1266	3591
Mar	27	107	712	1004	87	80	1731	491	119	1010	5368
Apr	28	228	194	192	65	199	843	533	51	1194	3525
Aug	241	231	4888	348	680	119	2083	465	0	640	9694
Sept	259	878	1163	1650	842	1315	4294	1118	35	999	12552
Oct	74	1418	1145	2656	37	2724	2550	1082	368	1788	13842
Nov	353	173	565	1280	0	475	751	573	445	958	5574
Dec	177	25	237	306	0	45	240	300	10	698	2037

Pintail Bay is a 1,520 ac, open wetland unit, located at the north central portion of the refuge. As our northernmost wetland unit, Pintail Bay has been subject to wide water level fluctuations over the years with an average low of 845 ac (56% full pool, November) and high of 1,463 ac (94% full pool, February). Waterfowl use has been quite high over the years with Pintail Bay density, consistently the highest among non-sanctuary units (table 13; figure 38). Species composition was strongly dominated by northern shoveler during early fall; however, all 10 primary species were well represented throughout months. Abundance and density were highest in fall, with the highest spring use density at 3.7 ducks/ac (March), primarily comprised of green-winged teal, northern shoveler, and ruddy ducks. Foraging guild analysis is quite complex in this unit with multiple peak use periods occupied or shared among guilds. For example, granivorous species peaked at 5.3 birds/ac in August, but also experienced a secondary peak in October during the early hunting season. The August peak was followed by insectivores (predominantly northern shovelers) in September, and then by grazers in October (both American wigeon and gadwall). Overall density ranged from 0.2 ducks/ac (January) with a peak density of 16.3 birds/ac. in

Figure 38: Duck species composition and foraging guild density for Pintail Bay, 1970-98.



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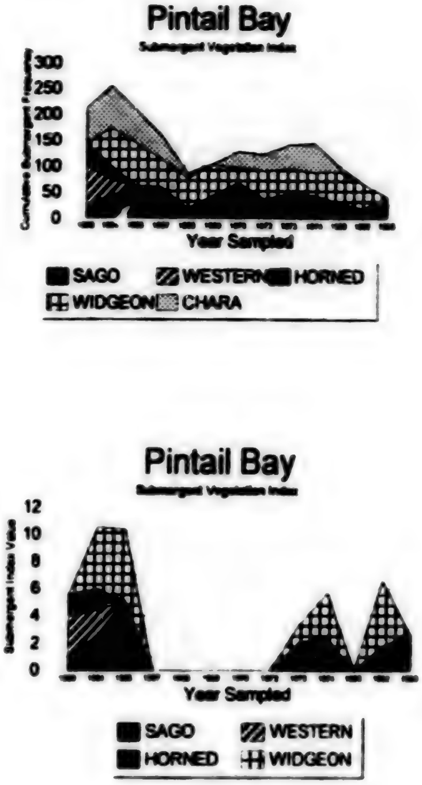
October. Similar to the Nutgrass Unit, this peak corresponds with the first month of the waterfowl hunting season.

Submergent vegetation frequency has been variable over the 13 years this unit was sampled with a nearly equal distribution of sago pondweed, chara, and wigeongrass (figure 39). While chara was not included in the submergent vegetation index, it would have resulted in similar index values as calculated for sago pondweed and wigeongrass. Water depth in this unit has averaged fairly shallow (27 cm) while salinity ranges are wide with a low of 3762 ppm and a high of 34,692 ppm (average 10,558 ppm). Water clarity has been low with an average depth of 11 cm, but unit shallowness and high salinity have facilitated growth of the three dominant species. Few sample points remained unvegetated (11.9%); however, low submergent vegetation index values represent only fair density over the years, which has likely resulted in relatively poor seed production in all but the earlier sample years.

Figure 39: Submergent vegetation availability by frequency and density in Pintail Bay, 1959-96.



Swan Lake

Table 14: Duck species numbers by month in Swan Lake, 1970-98.

Month	Mallard	Gadwall	Pintail	G.W.Teal	Cinn.Teal	Wigeon	Shovele	Redhead	Canvasback	Ruddy Duck	Total
Jan	50	0	93	27	5	10	92	31	32	78	416
Feb	111	10	528	434	23	34	202	105	177	662	2285
Mar	27	23	775	320	59	20	401	96	34	1226	2981
Apr	12	32	39	288	52	10	193	255	50	246	1177
Aug	131	174	1094	368	545	56	610	183		120	3280
Sept	294	170	434	442	249	136	440	191	50	327	2733
Oct	37	223	894	463	10	39	400	163	233	79	2542
Nov	80	69	439	1164	0	45	268	50	30	234	2378
Dec	62	35	199	346	0	60	200	150	50	341	1443

Swan Lake is a 1,880 acre unit subdivided into two separate subunits; Swan Lake and Swan Check. Located in the northcentral portion of the refuge, water levels are subject to fluctuation

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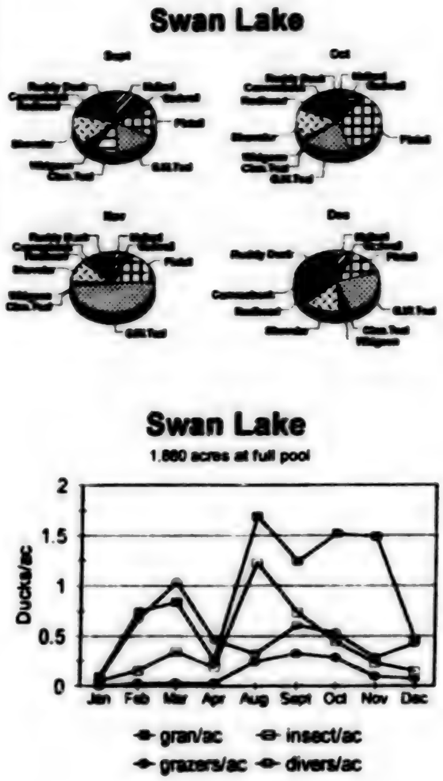
Figure 40: Duck species composition and foraging guild density for Swan Lake, 1970-98.



with a low acreage of 918 ac. (49% full pool, October) and a high of 1,776 ac (94% full pool, January) averaged over the survey period. This unit has remained fairly low relative to annual duck counts (table 14; figure 40). September species composition was evenly distributed among the 10 primary duck species; however, higher proportions of northern pintail followed by green-winged teal were associated with October through December surveys. Ruddy ducks represented a large percentage of the December count, but the peak for this diving duck occurred in March (1,226). Overall duck density was relatively low compared to other Stillwater NWR wetland units ranging from a low 0.2 ducks/ac (January) to a high of 3.5 birds/ac in August. Duck numbers progressively dropped over the hunting season from August through January. Spring densities were also relatively low and primarily comprised of northern pintail, northern shoveler, and ruddy ducks.

Submergent vegetation establishment over the 11 sample years, has been variable with all five submergent species represented along transects (figure 41). Submergent vegetation transects have been located in the southernmost segment of this unit which is typically deeper than northern arms of the unit (average 33 cm). Considering this units location, salinity ranges were surprisingly low ranging from 2,980 ppm to 6,720 ppm (average of 3000 ppm). No water clarity samples were collected during the 11 sample sessions corresponding to the years data were collected (1959-1983). Samples were not collected from 1984-1995 based on dry conditions.

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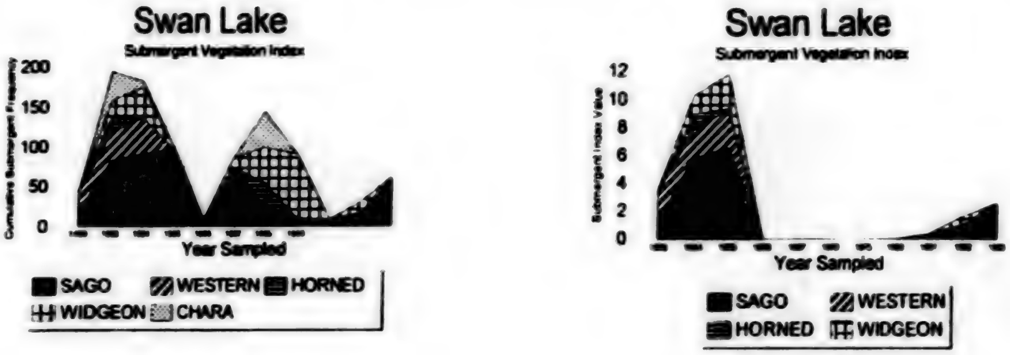
Figure 41: Submergent vegetation availability by frequency and density in Swan Lake, 1959-96.



From 1959-1965, submergent vegetation index values were high with a peak index value of 11.74 recorded in 1965. This was the second year following unit hydration which exemplifies the resilience and drought tolerance of submergent vegetation species. Index values were quite low during the early 1980's and then were non-existent until the past few years. Overall, duck use has been fairly low (with the exception of granivorous species), while submergent vegetation has been variable with no samples available to evaluate recent years.

Tule Lake

Tule Lake is a 1,245 ac unit located in the center of the Stillwater NWR open area. Ranging from 771 ac (62% full pool, August) to 1,198 ac (96% full pool, March), this unit has been more consistently hydrated during spring months (January through March), with waterfowl numbers responding to this trend (table 15, figure 42). High average duck counts of 7,258 and 5,619 were

Table 15: Duck species numbers by month in Tule Lake, 1970-98.

Month	Mallard	Gadwall	Pintail	G.W.Teal	Cinn.Teal	Wigeon	Shoveler	Redhead	Canvasback	Ruddy Duck	Total
Jan	117	23	293	360	30	45	28	217	412	442	1967
Feb	166	73	560	807	40	150	1053	153	1802	2455	7258
Mar	43	72	726	880	177	36	1249	76	105	2254	5619
Apr	24	140	26	936	122	360	612	64	180	957	3420
Aug	207	153	446	590	447	32	711	192	30	100	2908
Sept	343	167	774	1175	401	100	1646	264	58	385	5314
Oct	96	331	775	302	140	488	758	276	349	875	4389
Nov	146	113	707	415	0	78	507	262	560	484	3272
Dec	118	106	432	163	0	40	325	60	180	617	2042

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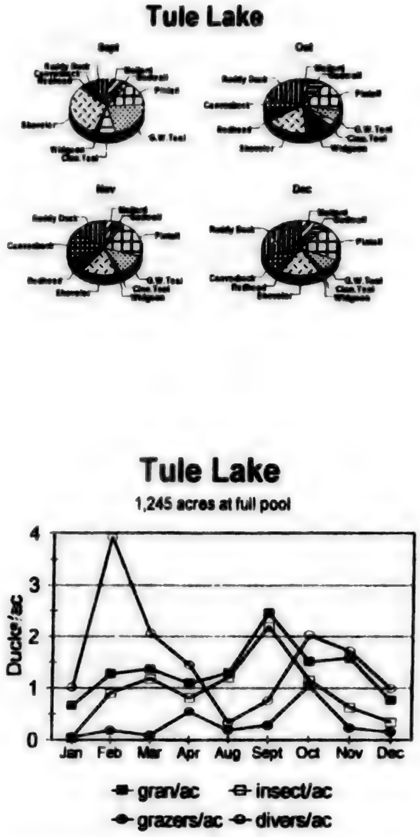
Figure 42: Duck species composition and foraging guild density for Tule Lake, 1970-98.

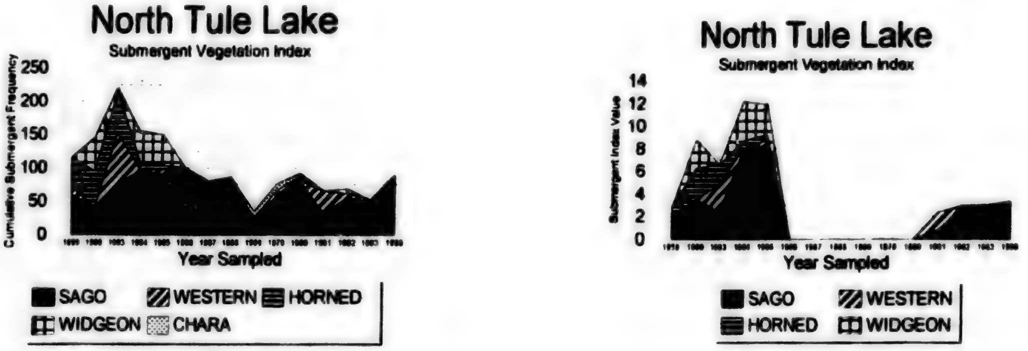


documented for February and March, with ruddy ducks the most prominent species during both periods (34% and 40%, respectively). Other important spring migrants included northern pintail (560/570), green-winged teal (807/880), and northern shoveler (1,053/1,249); however, all of these species experienced peak population levels in fall. Species composition during fall varied by month, with northern shoveler, green-winged teal, and northern pintail represented throughout the year. Canvasback numbers increased until November and then dropped off through December, although ruddy ducks were still the highest use, diving duck species.

Foraging guilds also differed by period with all guilds but diving ducks experiencing peak density in September or October. Diving ducks displayed a bimodal peak with February and October highs recorded (3.93 and 2.02 divers/ac). Overall density was fairly low with a peak of 6.3 ducks/ac occurring in February. Similar to most non-sanctuary units, fall peaks occurred in September and October, with decreasing density as hunting season progressed.

Submergent vegetation production was excellent during the early years at Tule Lake (figure 43).

Figure 43: Submergent vegetation availability by frequency and density in Tule Lake, 1959-96.



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Between 1959 and 1965, a large percentage of the marsh was covered by a mix of sago pondweed, western pondweed, horned pondweed, and wigeongrass with submergent vegetation indices ranging from 6.2 -12.2. Index values were not available from 1966-80; however, these values were considerably lower from 1981-present. Tule Lake's average depth (43 cm) and relatively low salinity range (1132 ppm to 5147 ppm), was ideal for sago and western pondweed growth and poor index values during the mid 1980's-96 cannot be explained. Over the 15 years this unit was quantitatively sampled, vegetation occurred at 82% of transect points. Overall, this unit would rate fair to good for waterfowl use and good for submergent vegetation production, with spring apparently, the most attractive month for migratory waterfowl.

West Marsh

Table 16: Duck species numbers by month in West Marsh, 1970-98.

Month	Mallard	Gadwal	Pintai	G.W.Teal	Cinn.Tea	Wigeon	Shovele	Redheac	Canvasbac	Ruddy Duc	Total
Jan	35	0	0	50	0	0	0	0	0	460	545
Feb	69	12	445	812	55	50	90	120	95	155	1903
Mar	58	18	777	1175	58	60	323	225	175	900	3768
Apr	32	74	37	204	100	30	645	94	23	236	1474
Aug	131	138	240	452	589	23	553	94	0	150	2370
Sept	149	253	393	476	1246	129	658	253	0	123	3679
Oct	40	605	113	2033	30	0	618	0	0	170	3608
Nov	62	100	412	1782	0	25	206	0	0	65	2651
Dec	170	15	93	975	0	0	175	30	20	310	1788

West Marsh (2,830 ac at full pool), encompasses West Marsh, Millen Lake, and Willow Lake. Rarely full during the survey period, West Marsh ranged from 560 ac (19.8% full pool, March) to 2,123 ac (75% full pool, February), with an annual average of 1,402 ac (50% full pool). West Marsh was only hydrated 8 years from 1977 - present, with wetland acreage not maintained throughout most sample years. Duck species responded accordingly with shallow, ephemeral habitat species comprising the largest percentage of annual use (table 16). Green-winged teal, cinnamon teal, northern shoveler, and northern pintail were the primary species utilizing this unit with ruddy ducks contributing to overall composition from December through March. Green-winged teal comprised more than 50% of total species use during hunting season months (56%, 67%, and 55%, respectively, for October, November, and December; figure 44). By foraging guild, granivorous species were strongly dominant in all months but January (diving ducks, 69% ruddy ducks), and August - September (insectivores, >50% cinnamon teal). Proportionally, this unit maintained the largest percentage of shallow water foraging specialists of all Stillwater NWR wetland units evaluated in this analysis.

Relative to infrequent hydration schedules, West Marsh has not produced submergent vegetation as well as other units; however, this unit was only sampled 4 times (1962, 64, 65, and 68) over

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the 1959 - 1996 survey period with drought common even during the 1960's (figure 45). When surveyed, West Marsh averaged 49 cm in depth, and had salinity ranges from 1,813 ppm to 2,475 ppm (average of 1,997 ppm). Water clarity was poor (11 cm) and 64% of transect points remained unvegetated across sampling periods. As a result, frequency and submergent vegetation index values remained low with a peak submergent index of 4.5 recorded in 1965. With the low salinity readings, sago pondweed and western pondweed were the two most common submergent species; however, infrequent hydration and corresponding ephemeral conditions did not allow for a significant submergent vegetation component in this units soil seed bank. Overall, West Marsh does not retain duck numbers as most other units have; however, this unit has been important for shallow water foraging specialists among years when it was at least partially hydrated.

Figure 44: Duck species composition and foraging guild density for West Marsh, 1970-98.

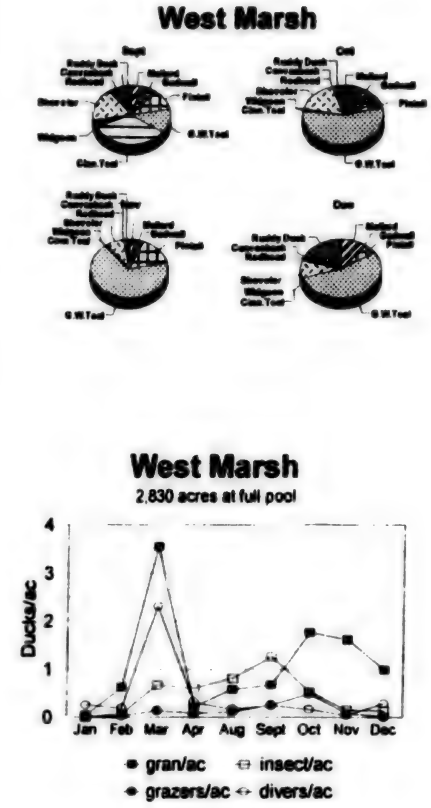
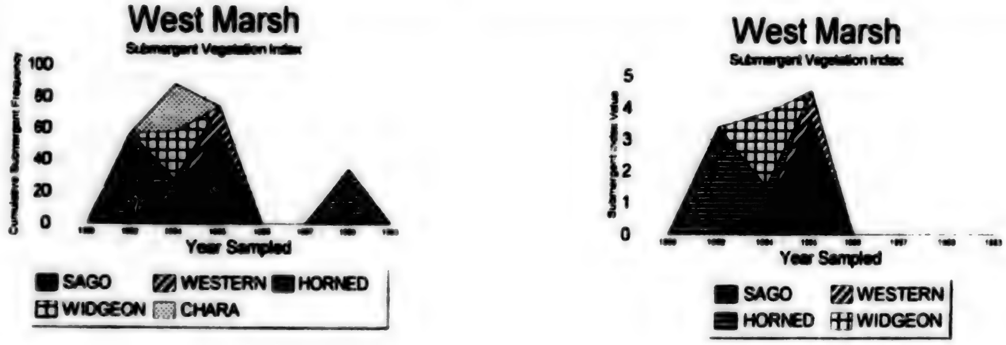


Figure 45: Submergent vegetation availability by frequency and density in West Marsh, 1959-96.



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Wetland Unit Rankings

Barber (1978), performed a ranking evaluation of Stillwater NWR wetland units based on overall waterfowl numbers, ducklings produced, and submergent vegetation production. Considering that Barber's analysis only covered a five year window, this evaluation will cover waterfowl use (based on duck density within wetland units), combined with submergent vegetation index values using long-term data sets. Waterfowl production has been infrequently monitored through Stillwater NWR's history, therefore, Barber's rankings will be included in this analysis, allowing for an evaluation of Stillwater NWR wetland units using all available data from 1959-1998 (table 17).

Table 17: A comparison of current wetland unit rankings by submergent vegetation production, duckling production, and annual waterfowl density, and Barber (1978) rankings, Stillwater NWR, 1959-98.

Wetland Unit	2000 Submergent Vegetation	2000 Waterfowl Density	Barber Duckling Production	2000 Overall Rank	Barber Overall Rank
Dry Lake	1	3	1	1	1
Pintail Bay	2	5	3	2	2
East Alkali Lake	3	1	12	3	11
Lower Foxtail Lake	4	4	10	4	5
Tule Lake	8	8	2	4	6
Upper Foxtail Lake	5	7	6	4	7
Cattail Lake	7	2	9	4	8
Nutgrass	9	10	4	8	3
Goose Lake	6	12	5	8	4
Lead Lake	14	9	8	10	13
West Marsh	12	13	7	11	10
Division Pond	13	6	14	12	14
Pt Reservoir	10	11	13	13	9
Swan Lake	11	14	11	14	12

The top two units, Dry Lake and Pintail Bay, have retained their overall rankings since the 1978 evaluation; however, some turnover has occurred among other units. East Alkali has become considerably more important, primarily based on ranking jumps in the submergent vegetation index (14 to 3) and waterfowl density (5 to 1). Submergent vegetation was not sampled in East Alkali Lake during Barber's (1978) study (see figure 25), suggesting that water was not directed to this unit between 1974 and 1978 in any quantity.

The poorest rated units, are typically deeper and/or located in the northwest corner of the refuge which are more subject to drought as limited water resources are redirected to shallower units with a better developed infrastructure. Lead Lake, Willow Lake, and Swan Lake are located in the northwest corner of the refuge, and with the exception of Lead Lake (which receives water from Canvasback Gun Club during fall), do not have an efficient delivery system. The latter two units have maintained an average of 48%/8 years and 57%/11 years fall water coverage, respectively (based on water coverage estimated from waterfowl surveys/years sampled from submergent vegetation surveys). Stillwater Point Reservoir has acted as a storage reservoir and has not been managed for waterfowl based on the need to maintain more northern units such as Foxtail Lake (87%/25 years), Dry Lake (86%/28 years), East Alkali Lake (67%/14 years), and Pintail Bay (59%/13 years).

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Table 18: Waterfowl density unit rankings, by foraging guild, for fall months (Sept. - Dec.), Stillwater NWR, 1970-98.

Wetland Unit	Granivores	Insectivores	Grazers	Divers	All Ducks
East Alkali Lake	3	3	1	1	1
Cattail Lake	4	1	2	5	2
Dry Lake	1	4	3	2	3
Lower Foxtail Lake	2	2	4	3	4
Pintail Bay	8	5	5	6	5
Division Pond	6	6	11	4	6
Upper Foxtail Lake	5	12	7	7	7
Pt Reservoir	7	10	9	9	8
Tule Lake	10	8	10	8	9
Nutgrass	9	7	8	11	10
Goose Lake	13	9	6	10	11
Swan Lake	12	14	13	13	12
West Marsh	11	13	12	14	13
Lead Lake	14	11	14	12	14

An examination of unit specific waterfowl density by foraging guild suggests that different wetland units are more important for different species of waterfowl (table 18). For example, East Alkali Lake is the number 1 ranked unit for total waterfowl density; however, this ranking is primarily related to grazing and diving ducks while granivores and insectivores received a number 3 ranking for this unit. The number 1 fall duck density ranking for the latter two guilds was held by Dry Lake (3 overall) and Cattail Lake (2 overall) which were the 1 and 4 ranked wetlands when all factors were considered (table 17). The top seven units during fall for granivores, and 6 of the top seven for all other guilds were sanctuary wetland units.

While many units maintained a relatively consistent ranking among foraging guilds, other units appear to be preferred by one guild over others, or conversely, have displayed a lower density of one guild compared to others. For example, Upper Foxtail Lake received an overall ranking of 4 (table 17), a total fall waterfowl density ranking of 7, and an insectivore ranking of 12. Apparently, this unit did not contain life history elements necessary for insectivorous species, primarily northern shoveler. Other units displaying this pattern include Pintail Bay (8 for granivores, 5-6 for other guilds), Division Pond (11 for grazers, 4-6 for other guilds), and Goose Lake (13 for granivores, 6-10 for other guilds).

Table 19: Relationship between submergent vegetation production and annual/fall waterfowl density at Stillwater NWR, 1959-98.

Category	r-squared	p-value
ANNUAL		
Total Ducks	0.3849	0.0179
Granivores/ac	0.2558	0.065
Insectivores/ac	0.2751	0.0542
Grazers/ac	0.0177	0.6505
Divers/ac	0.3754	0.0198
FALL		
Total Ducks	0.4456	0.0091
Granivores/ac	0.3825	0.0184
Insectivores/ac	0.4099	0.0137
Grazers/ac	0.4994	0.0137
Divers/ac	0.2969	0.0439

As a possible explanation for guild patterns within specific units, a regression analysis was performed with annual and fall guild density compared with submergent vegetation index values (table 19). The results of this

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analysis suggest that submergent vegetation quality has little effect on duck density within wetland units with grazing ducks displaying no relationship between grazer density and submergent vegetation ($r^2 = 0.0177$, $p = 0.6505$). While overall duck density was somewhat correlated with submergent vegetation quality ($r^2 = 0.3849$, $p = 0.0091$), remaining guilds did not maintain a significant p-value ($p<0.05$).

During fall, the relationship is somewhat stronger with all correlation coefficients significant at the $\alpha=0.05$ level. The strongest relationship occurs with grazing species (gadwall and American wigeon) with a correlation coefficient of 0.4994. Values drop from insectivores, granivores, to divers, with no explanation available for the poor correlation between diving ducks and submergent vegetation production. No correlation coefficients exceed 0.50, suggesting that interactions among a variety of factors, including other vegetative communities, may require evaluation to formulate hypotheses relative to waterfowl use of Stillwater NWR wetland units.

Discussion

Comparison of Separate Analyses

Through analysis of the separate results sections, it was necessary to use different subsets of the data to ensure that we were using all relevant and accurate data relative to the analysis focus. A close evaluation comparing results among these separate data sets will reveal some discrepancies in values offered. For example, the monthly wetland hydration schedules offered in figures 3 and 7 were prepared from an analysis of all observation periods where wetland acreage was recorded. These results include 0 values (where individual wetlands were dry) and considered two blocks (sanctuary and non-sanctuary areas) including Big Water and Battleground Point. While adding up the wetland unit calculations (Stillwater NWR Wetland Unit Evaluation section), only 14 units were used and average acreage was calculated for each individual wetland unit, only for years where the unit was hydrated. Therefore, 0 values were excluded in order to index wetland acreage relative to submergent vegetation production and duck density. This results in a schedule that displays a spring peak wetland acreage from the area analysis and a late winter peak in the wetland unit analysis. The former analysis is more indicative of total wetland acreage over time and should, therefore, be used to examine median and average wetland acreage values for the period evaluated. Each individual analysis in the results section should be referenced for the correct values for the parameters examined. With these thoughts in mind, the following discussion will examine the results of each independent analysis, and offer management suggestions to incorporate this information into Stillwater NWR management.

Waterfowl Population Chronology

Waterfowl use at Stillwater NWR becomes quite complicated when you consider that individual species vary in timing of use and preference for refuge habitats. For example, mallards and

Canada geese can be observed on the refuge during any month of the year, only absent when the wetlands completely freeze. Other species such as green-winged teal and American wigeon can be observed in the wetlands in all but summer months, while cinnamon teal, arrive in late spring, breed at the refuge, and then have migrated south by early October. Even with these species-specific chronological differences, the results of this analysis indicate that the largest waterfowl populations are present on Stillwater NWR between August and October.

Reasons for waterfowl population declines following October are unclear, but are likely related to a combination of natural migratory response, increasing public use pressure, depleted food reserves, and availability of other habitats in or adjacent to Stillwater NWR. With cinnamon teal, migration typically occurs before the onset of hunting season, thus increased public pressure beginning in early October and/or depleted food supplies would not appear to have much of an impact.

Species such as mallards are actively foraging on a combination of foods while redheads, American coots, American wigeon, gadwall, and other species are selectively foraging in submergent vegetation. It has been hypothesized that large numbers of birds foraging in submergent habitats during the August-October peak use period, lead to depleted seed reserves (Bill Henry, pers. comm.). This would provide one viable reason for decreasing waterfowl numbers following October.

Considering that many waterfowl species, particularly large-bodied species, tend to migrate only as far south as weather conditions dictate (Bellrose 1980:40, Simpson, 1988:537, Ringelman et al. 1989:325), population declines through October cannot easily be attributed to weather conditions. Bellrose (1980:41) offers that species specific migrations that occurs before weather and food become limiting "appear to be programmed in the endocrine system, probably going back eons in time when food shortages necessitated migration." This typically occurs with smaller bodied duck species (such as cinnamon teal), which are not equipped to tolerate extended cold periods.

Green-winged teal are an exception to this rule with the peak Stillwater NWR population occurring in November, and in most years, on into December and January. Considerable research has been conducted on this species and results suggest that they compensate for cold weather by foraging primarily at night, when energy produced through foraging helps maintain their high metabolism (Tamisier 1974). Based on analysis of time activity budgets, green-winged teal spent 90% of nocturnal hours foraging, while 60% of daylight hours were spent resting. Other nocturnal time activity budget studies reveal that mallards (Paulus 1984b, Magee unpublished doctoral dissertation), gadwall (Paulus 1984a), and northern pintail (Miller 1985), follow similar patterns as fall migration progresses. Possible reasons for this occurrence include increased metabolic efficiency for thermoregulation, decreased incidence of avian and mammalian predation, and avoidance of hunting related disturbance (Paulus 1987, Magee unpublished doctoral dissertation, Baldassarre and Bolen 1994, see Delong and Schmidt 1998).

Seasonal variation in diurnal activity patterns have also been documented which infer that other species (primarily dabbling ducks) spend considerable time foraging at night. For example, northern pintail spend 33%, 13%, and 7% of daylight hours feeding during August-September, October-November, and December-January, respectively (Miller 1985). Progressively more daylight time is spent resting, or in courtship activities over these periods, typically in open bodies of water in large flocks. Energetic demands tend to increase across these periods, thus logically, one could assume that more foraging time is required to meet these demands. This is similar to what is observed on Stillwater NWR with larger pintail flocks generally censused on large open bodies of water with extensive submergent vegetation (e.g., Lower Foxtail Lake, Pintail Bay, and North Nutgrass). These data would suggest that pintail are not actively foraging in these large open water bodies, but are instead, using them as staging areas to nocturnally forage in nearby shallow wetlands. While diurnal activities such as pair bonding are extremely critical to eventual waterfowl production, waterfowl surveys conducted during late morning or midday periods, may erroneously consider that all needs of the species utilizing these wetlands are provided within the unit during that time period.

While it is possible that waterfowl are fulfilling all life history requirements within individual units, the occurrence of nocturnal foraging flights at Stillwater NWR would suggest otherwise. Any hunter who has spent time on the marsh shortly before sunrise or after sunset, has witnessed these flights with large groups of mallards, pintail and/or green-winged teal entering shallow wetlands, usually with rising water levels. All three of theses species prefer shallow water for foraging (<8 in; Fredrickson and Taylor 1982), which is typically available near shoreline or in smaller units where disturbance pressure is greater (avian, mammalian, and human). Therefore, it would appear with these granivorous species, that social interaction and rest occur on large wetland units during the day, while foraging occurs in shallower sites during night as cold weather and disturbance increase throughout fall and early winter months.

Seasonal Distribution of Duck Species

Based on the results of this analysis, there is very little question that hunting related disturbance changes distribution of waterfowl populations on the refuge (figure 5). From 42-69% of all waterfowl inhabit 25-30% of Stillwater NWR wetland area (the proportion found in the sanctuary) from October - January. Prior to hunting season, roughly equal proportions utilize hunted and sanctuary wetland units while following hunting season, more ducks utilize hunt area habitats. However, the question still remains whether waterfowl are fulfilling their life history requirements while at the refuge. In other words, are the needs of waterfowl being met during the waterfowl hunting season at Stillwater NWR?

Certain species such as canvasback, appear to select sanctuary habitats throughout the year, but significantly alter distribution to sanctuary wetland units after hunting season commences. All species displayed a distributional shift to sanctuary wetlands in October. While not observed at Stillwater, canvasback on the upper Mississippi River, feed nocturnally, as higher quality feeding areas are subject to higher levels of hunting disturbance (Thornburg 1973). Preferred diet at this location consisted of hardshelled invertebrates (fingernail clams (pelyepoda) and snails (Gastropoda)) with very little vegetative material found in esophageal analyses (Gale 1969, Thompson 1969, Thornburg 1973). Pelycepods and gastropods have been found at higher densities in sanctuary wetlands at Stillwater NWR (Bundy 1997), providing for the possibility that this shift may be related more to habitat preference as opposed to disturbance tolerance.

Granivorous species (mallard, northern pintail, and green-winged teal) display the most profound distributional shift among foraging guilds examined in this analysis. Habitats preferred by these species are not more prominent on sanctuary wetlands and the observation of nocturnal foraging flights suggest that they are moving to other wetland areas to acquire bioenergetic reserves. As suggested in the previous discussion, sanctuary wetland units are more open and typically dominated by submergent vegetation, providing ideal conditions for diurnal activities including resting, courtship, and predator avoidance. But, activities such as flight are energetically costly (12.4 - 15.3 times basal metabolic rate; Prince 1979), thus, proximity to suitable foraging sites would appear important to providing for the fall requirements of dabbling duck species.

Sanctuary wetland habitats are relatively close to the nearby Canvasback Gun Club and agricultural lands located southwest of the refuge. Canvasback Gun Club only hunts on Wednesday, Saturday, and Sunday and focuses on fall waterfowl habitat provision so it is possible that granivorous species are acquiring forage resources on non-hunt days or at night at this location. This does not explain the distributional shift where granivorous ducks are observed at higher densities in hunt area units prior to and after hunting season (figure 11). This would suggest that for granivores, hunting related disturbance pushes birds into lower quality habitats whereby, adaptation is required to obtain necessary life history elements. The impacts of this adaptive shift cannot be quantified through analysis of these data.

Carson Lake and Stillwater Marsh Comparison

It has been hypothesized that fall waterfowl population decreases at Stillwater NWR. are compensated by increasing waterfowl densities at other locations within the Lahontan Valley landscape. It was believed that Carson Lake, which, similar to Canvasback Gun Club, focuses primarily on fall and later spring habitat management, would increase in waterfowl numbers as Stillwater declined. As figure 12 displays, this is not the case, and although Carson Lake tends to maintain, or slightly increase in their November waterfowl population, overall Lahontan Valley totals decline similar to Stillwater NWR.

This is primarily related to the overall waterfowl numbers which utilize the respective areas, with Stillwater NWR typically holding 75% of fall migratory duck species. This can partially be explained by geographic location with Stillwater NWR as the first location that northern or northeastern migrants would arrive. After arrival, it would seem likely that species would move throughout the respective wetland areas and the valley, seeking preferred habitats in which to acquire energetic reserves for further migration. To some extent, this would appear to be the case, with larger proportions of dabbling duck and diving duck species untilizing Carson Lake and Stillwater NWR, respectively. However, for all duck species and foraging guilds, larger numbers and densities are recorded for Stillwater through all periods except spring. This difference is much more prominent during waterfowl hunting season with 3 times as many ducks utilizing Stillwater NWR.

This would suggest that disturbance not only impacts Stillwater NWR waterfowl distribution, but also, Lahontan Valley distribution when you consider that until recently, Carson Lake did not provide any non-hunted area during the waterfowl hunting season. More recently, Carson Lake has provided a sanctuary area in the Sump unit and this past hunting season, imposed a boating restriction during four weekdays. Recent Carson Lake waterfowl use data following implementation of these restrictions were not available for analysis; however, this information may be the best available to quantify seasonal impacts relative to hunting disturbance among the Lahontan Valley wetland areas.

Habitats available at these two sites would appear to be the primary factor influencing seasonal waterfowl use. Stillwater has typically focused on maintenance of submergent vegetation throughout summer months to promote waterfowl breeding and to provide food for fall migratory waterfowl. Carson Lake has provided breeding habitat, but can also provide flooded pasture habitats which are heavily utilized by geese, dabbling ducks, and during spring, prebreeding waterfowl and shorebirds. It is interesting that Carson Lake duck populations surpass Stillwaters during March which leaves some question as to whether habitat provision, or geographic distribution is the more important element (with northward migrants arriving at Carson lake first). The answer likely resides somewhere between these two hypotheses.

Just as Stillwater NWR is the first arrival location for fall migratory waterfowl, Carson Lake would be the first during spring migration. This would appear to be more important during spring as habitat specialization is not as pronounced among waterfowl species. During prebreeding periods, nearly all duck species incorporate aquatic invertebrates as a large proportion of their diet, primarily to build up protein reserves for egg formation and prebasic molt (Krapu 1979, Baldassare and Bolen 1994). In the Lahontan Valley, invertebrate resources are best provided and most available in wet meadow and moist-soil habitats with densities of 1,285 total invertebrates/m^2 recorded in wet meadow habitats (Bundy 1997). A large percentage of Carson lake habitat is in shallowly flooded, grazed pasture status which provides ideal foraging conditions for birds (e.g., ducks and shorebirds) selectively foraging on invertebrates or grazing on spring germinating grasses (e.g., Canada geese).

This habitat type distribution also helps explain seasonal use by the four foraging guilds considered in this analysis. Carson Lake is strongly dominated by granivorous and insectivorous species (typically specializing in shallow habitats), while a more even mix among guilds is observed at Stillwater. The complexity of Stillwater marsh is one possible answer as a variety of different habitats, water depths, and related forage items are available on an annual basis.

Although not considered in this analysis, piscivorous species (e.g., common merganser) are almost exclusively observed at Stillwater, which can be explained with fisheries resources maintained through breeding duck and summer submergent habitat maintenance. Therefore, a combination of habitat provision (and related preferences among waterfowl species), human disturbance, and geographic location, would appear to influence waterfowl seasonal use patterns within the Lahontan Valley.

Stillwater NWR Wetland Unit Analysis

Through this analysis (waterfowl and submergent vegetation data), there are several general paradigms which can be gleaned relative to Stillwater NWR wetland units including:

1. Southern units tend to remain more perennially hydrated than northern units
2. Submergent vegetation production is typically better in the southern units
3. Salinity gradients, from south to north, tend to dictate which submergent vegetative species will become established
4. Waterfowl densities are typically higher in larger, open units
5. Fall waterfowl densities are generally highest in sanctuary wetland units
6. Specific wetland units provide for the seasonal needs of specific species and guilds

At first glance, it would appear that the factors considered, wetland acreage, submergent vegetation production, and average waterfowl density, would be the best indicators of waterfowl use patterns at Stillwater NWR. However, the poor relationship between submergent vegetation indices and most foraging guild specific waterfowl use would suggest that these are important factors, but not the only factors related to seasonal distribution, and further, may not be the most important indicators relative to waterfowl use potential of the Stillwater Marsh.

September through December waterfowl use shifts would suggest that habitat type selection is not necessarily related to wetland unit selection and that disturbance likely has more influence on habitat utilization by most species. Waterfowl are one of the most adaptable wildlife groups (Bellrose 1980); therefore, these impacts may not be at a level which adversely effects this groups survival while at Stillwater or at other points during annual migration. It is likely, however, that habitat management strategies and philosophies primarily incorporated to benefit this group, misrepresent the seasonal importance of submergent vegetation, and greatly underestimate the importance of other habitat types common to the Stillwater Marsh.

For years, alkali bulrush (*Scirpus maritimus*) was considered one of the most important food plants produced for waterfowl in Great Basin marshes and managers produced vast acreage of this shallow emergent species (Kadlec and Smith 1989). More recent research indicates that while alkali bulrush contains a high energetic content, it is low in crude protein and difficult for most waterfowl species to digest (Pederson and Pederson 1983, Miller 1987), suggesting that promotion of this species may be adverse to the migrational needs of waterfowl. Alkali bulrush does provide suitable nesting sites for a variety of waterbirds including American coots, Redheads, and to a lesser extent, canvasback, so this vegetative species does help fulfill other waterbird life history requirements.

Submergent vegetation, primarily sago pondweed has also been considered one of the most important waterfowl food plant among Great Basin habitats (Kadlec and Smith 1989). All vegetative parts are consumed by a variety of waterfowl species and foraging guilds, energetic content is quite high (Kantrud 1990), therefore, for the majority of waterfowl species utilizing Great Basin habitats, sago pondweed is likely the most important food item. However, sago is not the only plant utilized by waterfowl and, while it appears to provide for some elements of waterfowl life history strategies, a focus on one species or habitat type, over the complement of species available would be shortsighted.

All submergent vegetative species are important to various waterfowl species and guilds with wigeongrass heavily utilized by American wigeon, green-winged teal, and northern pintail (Gorden et al. 1987, Kantrud 1991), horned pondweed by lesser scaup and northern shoveler (Hurley 1990), and chara by American wigeon (Kadlec and Smith 1987). Submergent vegetation also provides valuable invertebrate substrate, although fairly simple invertebrate communities comprised of few species are often associated with their occurrence at Stillwater NWR (Bundy 1996). However, submergent vegetation is widely distributed throughout Stillwater NWR wetland habitats while other wetland plant communities, such as wet meadow, moist-soil, and emergent comprise a relatively small percentage of wetland units.

This analysis would suggest that most sanctuary wetland units and much of the hunted area are strongly dominated by submergent vegetation. These units can be characterized by high seasonal waterfowl use (primarily during hunting season months), but as indicated earlier, these habitats are not necessarily providing forage for granivorous species, and are certainly providing little cover for thermoregulation for the majority of late fall and winter duck populations. Similarly, non-sanctuary units such as Tule Lake, Pintail Bay, North Nutgrass, and Goose Lake are providing excellent stands of submergent vegetation, but with the exception of North Nutgrass, provide little in the way of other vegetation in most years. A small percentage of Pintail Bay, primarily at the southern end, contains other vegetation types; however, in most years, submergent vegetation is strongly dominant in this unit. Shoreline complexity in Tule Lake would aid in providing thermoregulatory and disturbance related benefits, however, most of this unit, like the others considered, are dominated by submergent vegetation communities.

Altering water management in these units to produce wet meadow, moist-soil, and emergent vegetation could meet with limited success, considering that continued perennial water, and resulting submergent vegetation establishment, have likely shifted seed bank composition to submergent vegetation seeds, tubers, and rhizomes (van der Valk 1981, Kadlec and Smith 1989). Submergent communities are very important to waterfowl, and it may not be productive to attempt to shift units where years of management have produced productive submergent

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vegetation stands, to communities that may not be available in the seed bank. However, other units have experienced more ephemeral water conditions over the years and annual plants and grasses germinating during drawdown, are likely plentiful in the seed bank . Units such as Swan Lake and Willow Lake appear to contain these elements, and if salinity can be reduced to a level that supports germination (Kadlec and Smith 1989), these units would appear to be the most conducive to promoting establishment of other habitat types contributing to waterfowl use at Stillwater NWR.

Wetland Unit Rankings

Factors used for ranking wetland units may not incorporate all elements necessary for an accurate assessment of unit importance to waterfowl. Waterfowl tend to move into sanctuary wetlands during hunting season months, therefore, the importance of the submergent habitat type may be overestimated in unit rankings. Additionally, how waterfowl species and guilds are utilizing submergent vegetation should be considered (i.e., resting, courtship, and/or foraging), and where species are going during nocturnal foraging flights needs to be determined. With this information, it would then be possible to accurately assess the importance of individual units for waterfowl species.

Five of the top seven units in this ranking are sanctuary units which exemplifies this finding with the top two non-sanctuary units, Pintail Bay and Tule Lake, characterized by large open areas dominated by submergent vegetation, and road closures which restrict vehicular access to portions of the unit. This combination of openness and restricted access would suggest that species may be utilizing these units as a means to minimize disturbance impacts. Additionally, if granivorous species are utilizing these open units more for resting and courtship areas (as offered earlier in this discussion based on nocturnal foraging), then foraging unit importance is underestimated for this guild.

Among foraging guilds, correlation coefficients for waterfowl density and submergent vegetation index values are poor when all months are considered. This result is particularly interesting when you consider that grazing species (gadwall and American wigeon), which are believed to specialize in submergent vegetation (Bellrose [illegible]), have the poorest correlation at Stillwater NWR (table 19). This pattern is completely opposite during fall, with the highest correlation coefficient calculated from August - December for grazing species (0.4994, $p < 0.05$), as it is for all foraging guilds except diving ducks, which have a stronger relationship with submergent vegetation when all months are considered. To understand this relationship, it is again important to understand the life history requirements among species within particular guilds and the diurnal use patterns within different time periods.

For grazers, there is a spring shift towards a more invertebrate dominated diet prior to breeding and molting (consistent among most species and guilds). Prior to and during breeding, gadwall shift to a diet containing 72% animal matter, comprised of insects and crustaceans (Swanson et al.

1979), which have been shown to be less abundant in Stillwater NWR submergent habitats (Bundy 1996). The poor correlation between diving ducks during fall and submergent vegetation indices cannot be easily explained based on life history requirements as the literature indicates that the two dominant fall species (redhead and canvasback) tend to focus on sago pondweed and other forms of submergent vegetation (Bellrose 1980). If consistent with the Mississippi River data (Thornburg 1973), and Stillwater canvasback are selecting for hard shelled invertebrates (e.g, gastropods), it is possible that submergent vegetation fringed by emergent vegetation (hemi-marsh; Weller and Spatcher 1965) would be the more appropriate indicator as gastropod density is typically highest in emergent habitats at Stillwater NWR (Bundy 1997).

Sanctuary wetland habitats, regardless of reasoning, provide the most heavily used areas during hunting season months, which is when the largest waterfowl concentrations are found at Stillwater NWR. Among all foraging guilds, at least six of the top seven units (measured in duck density) occur in the sanctuary (all seven for granivores). While it is uncertain if this distributional shift is impacting condition of duck species utilizing Stillwater NWR during fall migration, it is likely that hunting impacts initiate this distributional shift.

Management Implications

It appears from this analysis that some modification to habitat management and/or public use strategies would seem prudent to adequately provide for waterfowl using Stillwater NWR. As initially suggested and considered in the Stillwater NWR Environmental Impact Statement for the Comprehensive Conservation Plan (CCP/EIS), additional sanctuary in more diverse habitat could be provided in the existing public use area. Additional data are needed to support such a change at this time; however, means to assess waterfowl condition should be developed and monitored in successive years to elucidate whether such a change would be necessary.

Habitat management strategies focusing on habitat types with limited distribution would be another method to improve waterfowl condition. Considering the data, undisturbed foraging habitat for granivorous species would appear to be an identified need for Stillwater NWR fall water management. Habitat types of importance to this foraging guild include shallowly flooded areas with a high density of small seeds for foraging, submergent habitats for diurnal use, and emergent habitats and/or units with high shoreline complexity (i.e., many coves with wind protection from a variety of directions) for thermoregulation. Ideally, these habitats would be located within close proximity to each other to minimize metabolically expensive behaviors such as flight. Areas where foraging habitat can be provided include pasture areas in the existing Stillwater NWR, and units towards the north end of the hunt area where ephemeral water supplies have provided an extensive annual plant component within the soil seed bank.

Additionally, it is possible to provide increased undisturbed foraging and thermoregulation habitat in the existing hunt area, without significantly changing the design of the existing public use program. While the C1 Alternative (Stillwater NWR CCP/EIS) would have closed down two

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Stillwater NWR wetland units to waterfowl hunting, a second C Alternative would retain all of the historic hunt area, provide a quality hunting experience for the majority of Stillwater NWR waterfowl hunters, while providing considerable undisturbed habitat during most days for migratory waterfowl. The C2 Alternative designates two Stillwater NWR units as walk-in only hunting areas, which will decrease disturbance relative to boat travel, presumably decrease hunter density in designated units, while providing a quality hunting experience for those individuals willing to walk to their hunting spots. During the 1998 and 1999 hunting seasons, 24.5% and 21.6% of Stillwater NWR waterfowl hunters used boats to access their hunting areas (unpublished data on file at Stillwater NWR) making walking the most common method to access hunting sites.

In theory, a walk-in only hunting zone would provide relatively undisturbed, daytime foraging habitat for a variety of waterbirds, while providing an additional opportunity for hunters seeking a low density hunt at Stillwater NWR. If access is restricted to designated points, accompanied by road closures and elimination of boats, waterfowl would be allowed access to the majority of selected units on most days, because it is anticipated that fewer hunters would be willing to walk great distances to hunt. Units where this strategy could be implemented must be large, and somewhat isolated, to create at least, a minimal barrier to the majority of hunters. While it is possible that hunter density may increase near access points, it is believed that hunter density will be greatly reduced further away from access points based on the effort required for hunters to reach these sites. Additionally, it is believed that more walk-in hunters would result in less disturbance than a few boats. At present, four units are being considered for this designation at Stillwater NWR: North Nutgrass, Pintail Bay, Swan Lake, and Willow Lake.

When waterfowl densities only are examined, Pintail Bay and North Nutgrass would be the logical selection as walk-in only hunt units. However, as previously discussed, how and for what reason waterfowl are using these sites is uncertain. These two units are both typically comprised of submergent vegetation communities, are large open units which provide diurnal staging areas for most species, and among other hunt area units, maintain the largest populations of waterfowl through fall months. Conversely, The other two units being considered, Willow Lake and Swan Lake, have maintained much lower waterfowl densities over the years, typically retain low submergent vegetation index values, and retain the lowest waterfowl populations during fall months. Initially, it appears that Willow and Swan Lake would not be good choices for this designation; however, a variety of factors must be considered in this analysis including:

1. What habitats are limited for species and guilds of migratory waterfowl?
2. What reasons and at what time are these units being visited by waterfowl?
3. What values can each unit provide for migratory waterfowl?
4. Which areas are most disturbance prone at present?
5. Which areas would provide the better opportunity for hunters to have a good chance to harvest birds in a low hunter density environment?

Open submergent habitats are relatively common at Stillwater NWR as nearly all sanctuary wetland units are primarily comprised of this habitat type. The unit rankings suggest that these are the most valuable for waterfowl use, but timing of use and location of units used during other time periods needs to be considered. Altering management to produce proportionally limited habitat components such as emergent, wet meadow, and moist-soil vegetation in these open submergent areas could be futile considering that continued submergent vegetation management has reduced the amount of other plant seeds available in the seed bank. However, Swan Lake and Willow Lake contain the appropriate seed bank constituents to promote growth of moist-soil and wet meadow habitat types.

The reasons Pintail Bay and North Nutgrass have the reported duck densities would seem clear from the previous discussions. These units provide large open areas where waterfowl can forage, rest, or communicate (courtship displays), depending on the foraging guilds utilizing them. As shown for granivorous species (mallards, northern pintail, and green-winged teal), these are important resting and communication areas; however, observation of nocturnal foraging flights, and the rates of nocturnal foraging activity reported in the scientific literature suggest that these units are not used primarily for foraging purposes among granivorous species. Past years observations (1995-99) suggest that increasing foraging activity occurs in units such as Swan Lake and Willow Lake with the onset of foraging flights occurring just following sunset and just after sunrise; therefore, the importance of these units to granivorous species has likely been underestimated based on the time when surveys were conducted.

Values provided by each unit appear equally clear. Large open units such as North Nutgrass and Pintail Bay provide protection from land based predators, and opportunities for various species and guilds to fulfill diurnal life history requirements; however, little thermoregulatory cover is provided for later season months. Swan Lake and Willow Lake are highly complex units with myriad coves, penninsulas, open pools, and an emergent vegetation shoreline (in the case of Willow Lake). While these units provide less protection from predators (as compared to North Nutgrass and Pintail Bay), they do provide foraging habitat and thermoregulatory cover for a variety of species. Habitat complexity is also more diverse in these units providing habitat for a variety of other fall waterbirds, while the relative submergent vegetation monoculture at Pintail Bay and North Nutgrass provide for few other than waterfowl and migratory shorebirds (during September and October).

While disturbance cannot be quantified from this analysis, it can be inferred through results of this analysis combined with related scientific information. The most important factor relative to disturbance would appear to be species and/or guild response to increased hunting pressure. As shown in the results, granivorous species display the most obvious distributional shift during hunting season with an apparent preference for hunt area units prior to hunting season and a strong presence in sanctuary units during hunting season. The top seven units granivores use during hunting season are the seven sanctuary units evaluated with Pintail Bay and North Nutgrass coming in 8 and 9 respectively (table 18). The lower ratings for Swan Lake and Willow

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Lake (11 and 12) may not account for increased utilization during different periods of the daily cycle.

Among hunted units, Pintail Bay is the only unit which has a density increase at the beginning of hunting season while North Nutgrass has similar densities in September and October. All other hunt area units see declines from September through October. This suggests two possibilities: open areas provide more security from disturbance and are, thus, more heavily used by waterfowl as hunting season progresses and/or the existing hunt program on Pintail Bay and North Nutgrass does not impact waterfowl distribution to the same extent as other hunted units, thus additional restrictions (such as a walk-in only hunt zone) may not be necessary on these units. The reasoning behind this is that birds can see forms of disturbance (whether mammalian (including humans) or avian) coming from great distances and can then respond accordingly. Whether in a boat or on foot in an open unit, ducks are going to observe the distraction as it begins and can either choose to remain or fly away as the disturbance vector approaches. In units such as Swan or Willow Lake, shoreline complexity and related high numbers of isolated coves and islands allows disturbance in one cove not to impact waterfowl activities in other coves. Boats in these units can easily access many coves during a single trip; however, a hunter on foot would not necessarily travel as far, access as many coves, or cause an easily observable approach such as a boat over water, thus minimizing disturbance in the majority of coves, throughout most days.

This same consideration also provides for a better hunting opportunity in Swan and Willow Lake. While birds may leave a particular cove or point an individual chooses to hunt, many other coves within the unit are likely not being hunted and are, thus, available for waterfowl use. The number of coves provides many opportunities for hunters to find an isolated location with few other hunters, where a good probability of being able to decoy birds exists. Implementing a walk-in only hunt at Pintail Bay or North Nutgrass would not necessarily provide the same opportunities as little cover is available within these units for hunters to walk in and hide. Most available hunting area is shoreline (excluding the southern portion of Pintail Bay) and is easily accessible by vehicle (except northern Pintail Bay) providing little opportunity other than already exists for hunting in these units. As stated, walking in is the most common method used to access hunting locations for most (>75%) of Stillwater NWR waterfowl hunters, and would provide an area where walk-in hunters would not need to be concerned about boating disturbance, or boat hunters who easily pass locations that walk-in hunters spent considerable effort accessing.

During waterfowl hunting season, Pintail Bay and North Nutgrass contain the highest average duck density among hunted units; however, the previous discussion has shown that Swan and Willow Lake would make the better walk-in only designation units at Stillwater NWR. Willow and Swan Lake appear to provide more benefits for fulfilling waterfowl life history requirements (including foraging habitat provision for granivorous species, open pools for resting and communication, and thermoregulation protection), likely have been used at higher rates outside of survey periods, and have seen waterfowl population decreases as hunting season progresses. Therefore, the opportunity exists to do more to provide a diversity of habitat types, fulfilling a wider variety of waterfowl life history strategies, while providing a better opportunity for the majority of Stillwater NWR hunters by designating Willow and Swan Lake as walk-in only access under the Stillwater NWR Comprehensive Management Plan.

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Table 1. Median densities (number/ha) for species of aquatic migratory birds in sanctuary and hunted wetlands at Stillwater National Wildlife Refuge, northwestern, Nevada, August - March, 1977-98.

Species	Sanctuary[a]	August	September	October	November	December	January	February	March	All months[b]
American wigeon	N	0.143(1)[c]	0.333(3)	0.745(1)	0.253(2)	0.029(4)	0(6)	0.064(1)	0.053(1)	0.104A[d]
	Y	0.218(0)	0.645(0)	1.892(0)	0.626(0)	0.080(2)	0.028(4)	0.050(1)	0.019(2)	0.149B
	N and Y[e]	0.181abc[f]	0.489bd	1.319d	0.440ad	0.055cd	0.014d	0.057cd	0.036cd	
Cinnamon teal	N	0.886(0)	0.282(0)	0.028(2)	(8)[g]	(8)	(8)	0.017(2)	0.159(1)	0.022A
	Y	0.369(0)	0.271(0)	0.155(3)	(8)	(7)	(10)	0.007(2)	0.113(0)	0.060A
	N and Y	0.628a	0.277ab	0.092cd	e	ef	e	0.012dfg	0.136bcg	
Green-winged teal	N	0.416(0)Aab	2.291(0)Aa	1.211(0)Aa	0.678(1)Aab	0.524(1)Aab	0.049(2)Ab	1.429(0)Aab	2.417(0)Aab	
	Y	0.209(1)Aab	0.666(0)Abc	6.489(0)Bd	7.437(0)Bd	1.710(1)Aabd	0.140(3)Aac	0.775(1)Aabd	0.719(0)Aabd	
Gadwall	N	0.499(1)	0.990(2)	0.786(0)	0.137(2)	0.060(2)	(6)	0.058(1)	0.086(0)	0.112A
	Y	0.693(0)	0.810(0)	2.639(0)	0.763(0)	0.159(1)	(7)	0.093(1)	0.066(1)	0.426B
	N and Y	0.596ab	0.900a	1.713a	0.450bc	0.110c	def	0.076ce	0.076cf	
Mallard	N	0.116(1)Aa	0.111(0)Aa	0.150(0)Aa	0.063(1)Aa	0.154(0)Aa	0.034(0)Aa	0.214(0)Aa	0.066(0)Aa	
	Y	0.357(0)Aab	0.549(1)Aab	1.931(0)Bc	1.678(0)Bac	1.414(0)Bac	0.349(0)Bbd	0.449(0)Aabc	0.097(0)Ab	
Northern pintail	N	0.767(0)	0.931(1)	1.409(0)	0.675(1)	0.563(0)	0.081(1)	0.493(0)	1.357(0)	0.721A
	Y	0.487(0)	0.728(0)	3.519(0)	1.958(0)	1.567(1)	0.213(2)	1.334(0)	0.755(0)	1.045B
	N and Y	0.627ab	0.830bc	2.464bc	1.317bc	1.065ab	0.147a	0.914bc	1.056bc	
Northern shoveler	N	1.402(0)	1.876(0)	3.830(0)	1.216(2)	0.382(1)	0.007(4)	0.303(1)	3.035(0)	1.309A
	Y	1.011(0)	1.877(0)	6.632(0)	2.753(0)	0.457(0)	0.119(2)	0.037(1)	0.259(0)	0.734A
	N and Y	1.207abc	1.877ad	5.231d	1.985ad	0.420be	0.063fg	0.170egh	1.647abch	
Canvasback	N	(7)*a[h]	(8)*a	0.042(3)Aab	0.079(3)Aab	0.019(3)Aab	(6)*ab	0.266(1)Ab	0.053(0)Aab	
	Y	0.006(5)*a	0.072(3)*ac	3.345(0)Bbd	4.068(0)Bb	1.630(0)Bb	0.037(2)*ac	0.386(1)Aab	0.486(0)Bbce	

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APPENDIX F:
Land Protection Plan

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U.S. Fish and Wildlife Service

LAND PROTECTION PLAN

Additions to the
Stillwater National Wildlife Refuge Complex
Churchill and Washoe Counties, Nevada

Prepared by

U.S. Fish and Wildlife Service
911 NE 11th Avenue
Portland, Oregon 97232-4181

April 2000

Approved by:

____
Regional Director
U.S. Fish and Wildlife Service

____
Date

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LAND PROTECTION PLAN

Stillwater National Wildlife Refuge Complex
Churchill and Washoe Counties, Nevada

1. INTRODUCTION

This Land Protection Plan (Plan) outlines habitat protection methods the U.S. Fish and Wildlife Service (Service) would use for the protection of additional lands in Churchill County, Nevada. The Plan presents the minimum interests in land needed to meet habitat and wildlife management goals for the proposed additions. The additions discussed below reflect boundary revisions to the Stillwater National Wildlife Refuge as proposed in the preferred alternative of the accompanying Environmental Impact Statement for the Comprehensive Conservation Plan and Boundary Revision (EIS)

Nothing in this Land Protection Plan constitutes an offer to purchase public property, a taking of public property, or a usurpation of the authority of the State of Nevada, Churchill County, or any other jurisdiction to regulate land use within the proposed additions. This Plan is intended to guide subsequent land protection activities subject to availability of funds and other constraints.

2. PROJECT DESCRIPTION

The Service proposes to add protect, restore, and manage up to:

- about 16,640 acres north of Stillwater National Wildlife Refuge; all of these lands are Federal public lands except 1,920 acres owned by Churchill County (Figure 1 and Map 1.4 in the accompanying EIS).

- about 3,840 acres along the Carson River south of the present-day Fallon National Wildlife Refuge; all of these lands are in private ownership except 560 acres owned by Churchill County (Figures 1 and 2).

- about 160 acres of private lands near the current western boundary of the Stillwater National Wildlife Refuge (Figure 1).

- up to 50,130 acres now within the Stillwater Wildlife Management Area (WMA), most of which are Federal public lands with a primary withdrawal by the Bureau of Reclamation (Figure 1 and Map 1.4 in the accompanying EIS). The Service currently administers these lands and would assume primary jurisdiction over them. The Paiute-Shoshone Indian Tribe has been exploring adding the southernmost 5,120 acres of this area to their Reservation; the Service would acquire these lands only to the extent that the Tribe does not acquire them.

Figure 1. Stillwater National Wildlife Refuge Complex Proposed Acquisition Tract Map

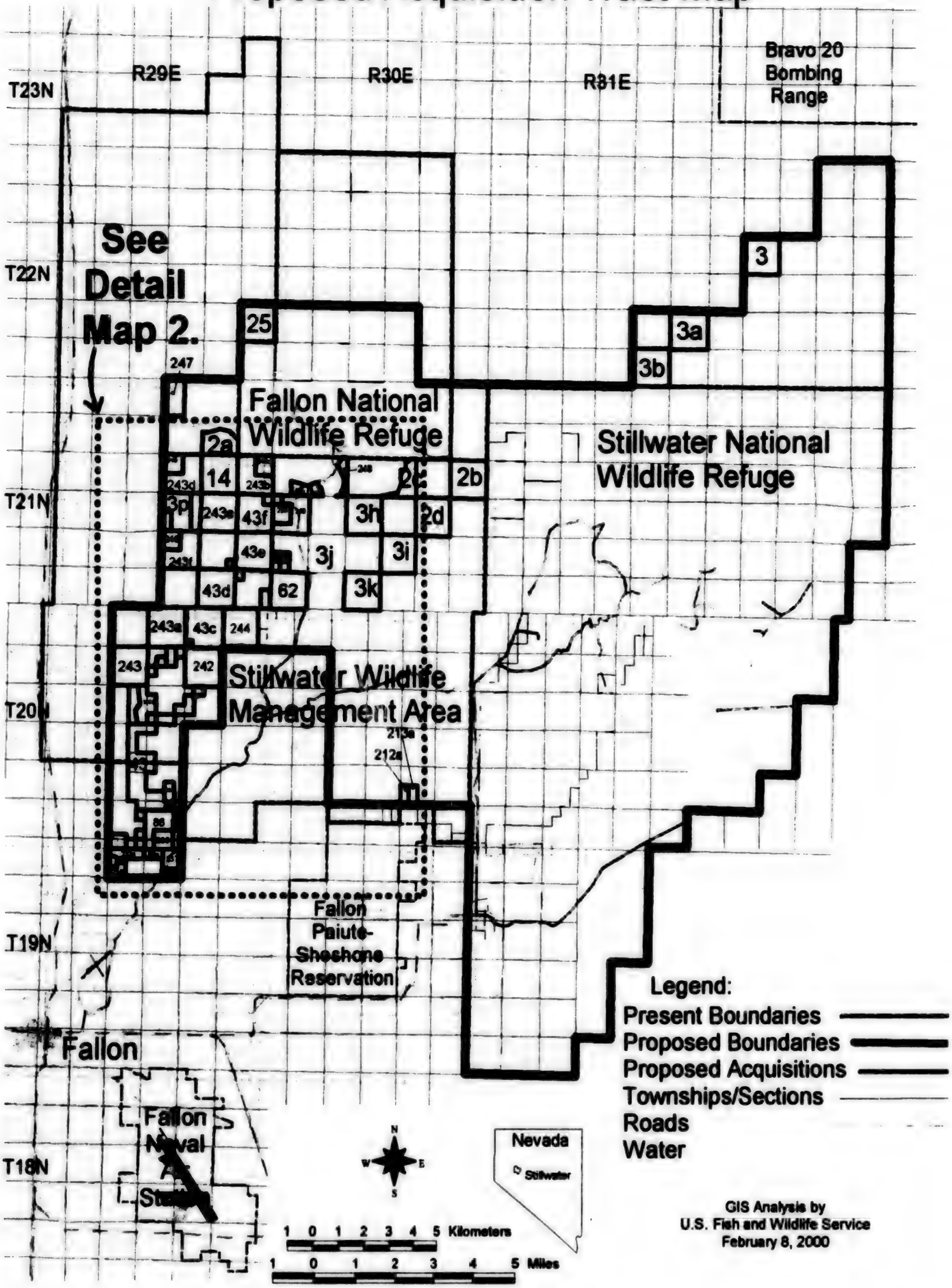

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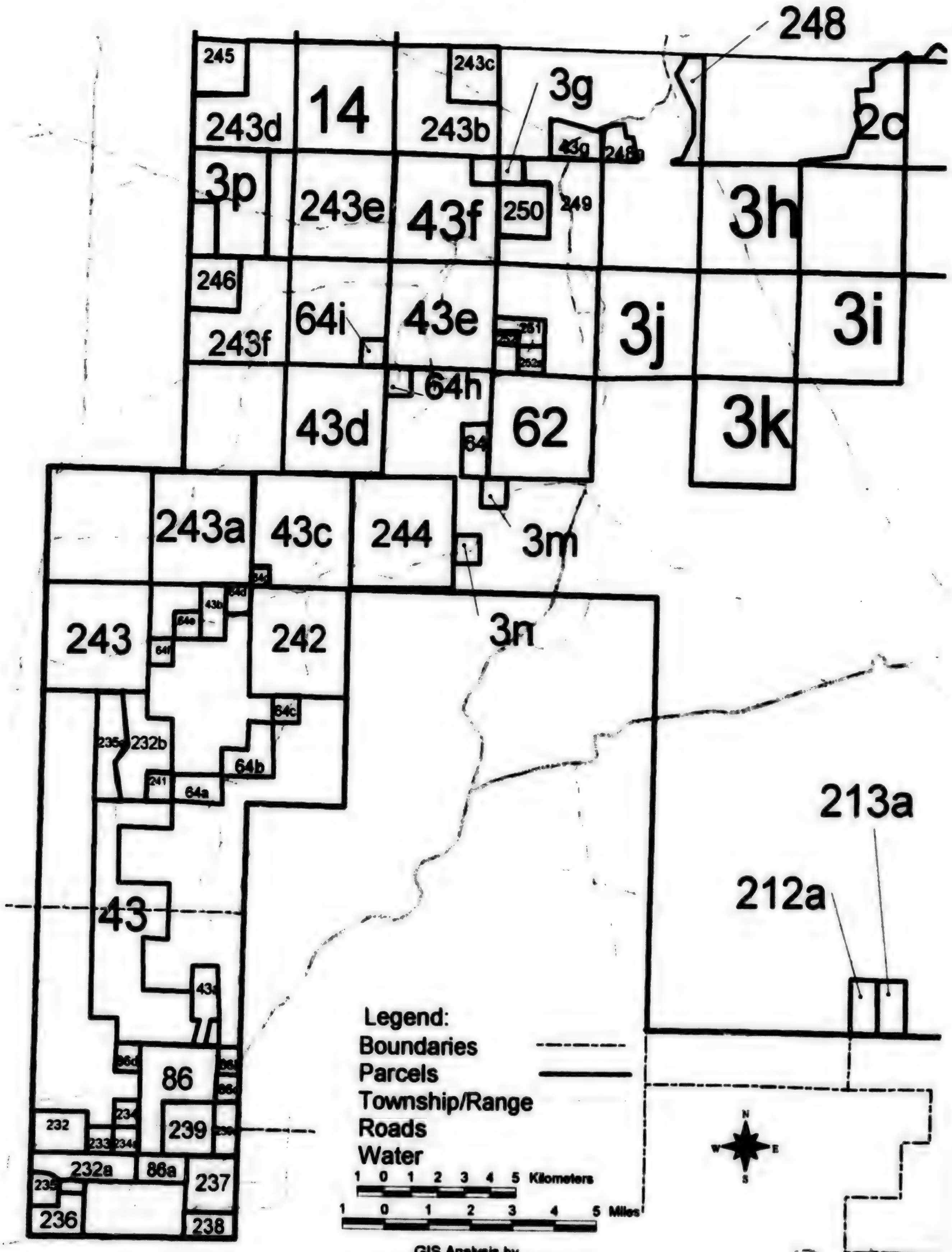
Figure 2. Land Ownership
Carson River Area



GIS Analysis by
U.S. Fish and Wildlife Service
February 8, 2000

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All of these up to 71,330 acres would become part of the Stillwater National Wildlife Refuge. The designation of Stillwater WMA would no longer exist. In addition,10,818 acres of the existing Fallon National Wildlife Refuge would be incorporated into the Stillwater National Wildlife Refuge. The remaining 7,030 acres of the existing Fallon National Wildlife Refuge would be removed from the National Wildlife Refuge System and conveyed to the jurisidiction of either the Bureau of Reclamation or public land status.

The Service's proposed action is described in more detail in the accompanying Environmental Impact Statement for the Comprehensive Conservation Plan and Boundary Revision (EIS). National Environmental Policy Act (NEPA) documentation should be completed before any boundary revisions are implemented. At the completion of this analysis, boundary revisions could be pursued administratively under the Fish and Wildlife Act of 1956 (16 U.S.C. 742a-742j), as amended. As an alternative, Congress could revise the refuge boundary through legislation. Congressional approval would be required to dispose of any lands now within Fallon National Wildlife Refuge from the National Wildlife Refuge System. The most appropriate course of action to implement any boundary revisions will be determined after completion of the NEPA process.

This land protection plan describes (in Section 7 below) the various habitat protection methods for lands within the proposed additions to the Refuge. Specific tracts, as shown on Figures 1 and 2, and their current owners are identified in Table 1. Priorities for acquisition among the various tracts have not yet been determined, but will be assigned prior to the Final EIS.

The Service proposes to acquire lands or interest in lands primarily under the authority of the Migratory Bird Conservation Act (16 U.S.C. 715-715d, 715e, 715f-715r). The Service would seek funding from the Migratory Bird Conservation Fund which is administered by the Migratory Bird Conservation Commission. This fund is maintained by congressional appropriations under the Wetland Loan Act (16 U.S.C. 715k-3-715k-5; 75 Stat. 813), as amended, and from Duck Stamp sales. The Service may also seek funding from the congressionally administered Land and Water Conservation Fund (LWCF). The LWCF is maintained by surplus property sales, certain motorboat fuels taxes, entrance fees for certain Federal areas, and revenue generated by off-shore oil and gas leases. The Service would manage this land under several authorities, including the National Wildlife Refuge System Administration Act of 1966 and the National Wildlife Refuge System Improvement Act of 1997.

3. THREATS TO AND STATUS OF THE RESOURCE

The underlying factors that hinder the achievement of wildlife and wildlife-related purposes of the Refuge include:

- reduced volume and altered timing of inflows, and flow restrictions;
- prevalence and spread of nonnative plant and animals species, including cattle;
- contaminated inflow and wetlands soils; and,
- size of refuges in relation to the area in which ecological processes operate.

Proposed additions to the Refuge would help the Service address all of these factors to some extent, but in particular the last factor. In the future, the additions may further Refuge purposes by allowing the Service to control unchecked or excessive human activity in these areas.

4. OBJECTIVES OF THE PROPOSED ACTION

The Service proposes to expand the Refuge boundary to protect, restore and manage up to 71,330 acres of lands. The Plan identifies habitat protection priorities for privately owned lands within the proposed additions and is developed principally as a guide for landowners in the project area. If an interest in these lands is acquired, they will be managed as described in the accompanying Comprehensive Conservation Plan. The management goals would be: 1) to conserve and manage fish, wildlife, and their habitat to restore and maintain biological diversity; 2) to contribute toward fulfilling obligations of international treaties and other international agreements with respect to fish and wildlife; and, 3) to provide opportunities for scientific research, environmental education, and wildlife-dependent recreation that are compatible with Refuge purposes. The Service proposes to acquire an interest in these lands using fee-title acquisitions, easements, donations or other sources.

5. PROTECTION METHODS

Willing Seller Policy. It is the policy of the Service to acquire land only from willing sellers under general authorities such as the Migratory Bird Conservation Act, the Endangered Species Act, the Fish and Wildlife Act of 1956, and the Emergency Wetland Resources Act. Landowners within the project boundary who do not wish to sell their property or any other interest in their property are under no obligation to negotiate with or sell to the Service. In all acquisitions, the Service is required by law to offer 100 percent of fair market value, as determined by an approved appraisal that meets professional standards and Federal requirements.

The Service, like other Federal agencies, has been given the power of eminent domain. Eminent domain allows the use of condemnation to acquire lands and other interest in lands, such as easements, for the public good. The Service very rarely uses this power. The Service normally acquires land from willing participants and is not often compelled to buy specific habitats within a rigid time frame. Most of the few Service condemnations that do occur are "friendly," that is, they are done with the consent of the landowner to determine legal ownership if there are multiple claims to the title, or settle a difference of opinion on appraised value.

In very rare cases, the Service has condemned private land when directed by Congress, as a last resort when all other negotiation attempts have failed to prevent land use that could cause irreparable damage to the resources for which the unit (refuge, etc.) was established, or to consolidate Federal ownership to effectively manage or develop the unit. Under condemnation, as in all purchases of land or real property interests, the Service is required by law to offer 100 percent of fair market value, as determined by an approved appraisal that meets professional standards and Federal requirements.

Habitat protection methods that could be used by the Service under this proposal are:

Cooperative Agreements. A landowner can lease certain development and management rights to the Service for reimbursement as specified by mutual agreement. The Service can enter into leases through purchase, donation, exchange, or transfer. The landowner pays any applicable property taxes.

The Service can also enter into cooperative agreements with landowners to improve wildlife habitat management. Cooperative agreements may specify shared responsibilities, or a transfer of funds from the Service to another entity or vice-versa for management purposes. Leases and cooperative agreements could be applied to land under any type of ownership.

Conservation Easements. Conservation easements are a type of refuge acquisition where the landowner permanently transfers some, but not all, property rights to the Service as specified by mutual agreement. Under a conservation easement, a landowner could agree not to engage in activities damaging to wildlife habitats, and the Service could manage the land for wildlife. The Service can acquire easements through purchase, donation, exchange, or transfer, depending on the terms of the easement. The property owner pays any applicable property taxes. The Service could negotiate conservation easements on land under any type of ownership.

Fee Title Acquisition. The Service acquires land by outright purchase (fee title) when (1) the lands's fish and wildlife resources require permanent protection that is not otherwise available, (2) the land is needed for development associated with public use, (3) a pending land use could otherwise harm wildlife habitats, or (4) purchase is the most practical and economical way to assemble small tracts into a manageable unit. Fee title acquisition transfers any property rights owned by the landowner, including mineral and water rights, to the Federal government. A fee title interest may be acquired by purchase, donation, exchange, or transfer. The Service could acquire in fee any lands.

6. COORDINATION

Federal, Tribal, State, and County governments; landowners, conservation organizations: and other interested groups and individuals have been notified of the proposal to protect, restore, and manage lands within the outer periphery of the Stillwater National Wildlife Refuge Complex. Discussion have been held with many of these individuals, organizations, and agencies, and governments. Mailings and personal contacts were used to solicit public comment. The Service has considered the public comments in preparing this Plan.

Copies of this draft environmental impact statement are being sent to Federal and State legislative delegations, agencies, landowners, private groups, and other interested individuals. The draft environmental impact statement is available at the Stillwater National Wildlife Refuge, 1000 Auction Road, Fallon, Nevada (775) 423-5128; at the California/Nevada Refuge Planning Office, 2800 Cottage Way, Sacramento, California, (916) 414-6500; and at the U.S. Fish and Wildlife Service's Regional Office, 911 NE 11th Avenue, Portland, Oregon (503) 231-2231.

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7. SOCIAL AND CULTURAL IMPACTS

The current quality of life for communities and individuals around the proposed additions to the Refuge is expected to be the same or better as a result of the Refuge addition. The Refuge would provide some wildlife-dependent public uses, thus increasing local and regional opportunities for wildlife-oriented recreation. Reductions in livestock grazing levels (in terms of permitted AUM's) on Refuge managed lands currently range from 20 to 50 percent, depending on the management alternatives. The estimated overall change from baseline conditions from implementation of the preferred alternative of the Comprehensive Conservation Plan is a reduction in annual revenues to the livestock sector of $12,000 to $18,000. This reduction, however, results from changes in management proposed throughout Service-managed areas, and therefore are greater than those to be expected from the proposed land acquisitions alone. In addition, both land acquisition and reductions in grazing levels are likely to occur over time, further lessening the economic impacts.

8. SUMMARY OF PROPOSED ACTION

The Service proposes to add protect, restore, and manage up to about 16,640 acres north of Stillwater National Wildlife Refuge, 3,840 acres south of the existing Stillwater Wildlife Management Area (WMA) along the Carson River, 720 acres west of the current Stillwater National Wildlife Refuge boundary, and up to 51,130 acres within the current Stillwater Wildlife Management Area (Figure 1). All of these up to 71,330 acres would become part of the Stillwater National Wildlife Refuge. The designation of Stillwater WMA would no longer exist. The methods for acquiring interest depends upon the interests of willing participants, but could include conservation agreements or easements, fee-title acquisition, or any other available method. A summary of the State, County, and private land, ownership, and approximate acreage, is provided in Table 1. Priorities for land acquisition have not yet been determined.

Table 1. Land Protection Priorities Within the Proposed Expanded Boundary of the Stillwater National Wildlife Refuge Complex

Tract Number	Assessor's Parcel Number	Owner	Service Intention	Priority	Acres
Federal Land North of Stillwater National Wildlife Refuge[1]					
-	-	Bureau of Reclamation	Transfer		14,720.00
Federal Lands within Existing Stillwater Wildlife Management Area[2]					
-	-	Bureau of Reclamation	Transfer		50,130.00
County Lands North of Stillwater National Wildlife Refuge[3]					
3	004-151-08	Churchill County Trustee	fee title, management agreement, transfer, exchange, easement,		640.00
3a	004-131-25	Churchill County Trustee	fee title, management agreement, transfer, exchange, easement,		640.00
3b	004-131-32	Churchill County Trustee	fee title, management agreement, transfer, exchange, easement,		640.00
Private Lands West of Current Stillwater National Wildlife Refuge Boundary[4]					
212a	003-391-13	Tom & Ellie Kent Family Trust	fee title/easement		80.00
213a	003-391-14	Robert & Muriel Kent	fee title/easement		80.00
Private Lands Along Carson River Southwest of Existing Fallon National Wildlife Refuge[5]					
32b	009-032-29	LN & MD DeBraga	fee title/easement		29.30
43	009-411-54	Wolf	fee title/easement		896.11
43a	009-411-53	W & BE C Wolf Trustees	fee title/easement		90.15
43b	009-411-15	Wolf	fee title/easement		80.00
43c	009-411-02	Wolf	fee title/easement		633.12
43d	003-711-41	Wolf	fee title/easement		640.00
43e	003-711-26	Wolf	fee title/easement		640.00
43f	003-711-24	Howard &BarbaraWolf Trustees	fee title/easement		600.00
43g	003-731-08	Wolf	fee title/easement		93.16
62	003-731-20	Thirty One Corp.	fee title/easement		640.00
64	003-711-44	Sloan	fee title/easement		80.00

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[1] See Figure 1 and Map 1.4 of accompanying EIS.

[2] See Figure 1 and Map 1.4 of accompanying EIS.

[3] See Figure 1.

[4] See Figure 1.

[5] See Figure 2.

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64a	009-411-25	Sloan, James & Florence	fee title/easement		40.00
64b	009-411-23	Sloan	fee title/easement		120.00
64c	009-411-22	Sloan	fee title/easement		40.00
64d	009-411-16	Sloan	fee title/easement		40.00
64e	009-411-14	Sloan	fee title/easement		40.00
64f	009-411-13	Sloan	fee title/easement		40.00
64g	009-411-03	Sloan	fee title/easement		40.00
64h	003-711-42	Sloan	fee title/easement		40.00
64i	003-711-28	James Sloan	fee title/easement		40.00
86	009-411-50	R J & LA Albaugh Trustees	fee title/easement		319.56
86a	009-411-38	RJ & LA Albaugh Trustees	fee title/easement		80.00
86b	009-411-40	RJ & LA Albaugh Trustees	fee title/easement		40.00
86c	009-411-41	RJ & LA Albaugh Trustees	fee title/easement		38.30
86d	009-411-36	RJ & LA Albaugh Trustees	fee title/easement		40.00
232	007-351-04	Albert & Delores Mussi Trustees	fee title/easement		120.00
232a	007-351-08	Albert & Delores Mussi Trustees	fee title/easement		190.42
232b	009-421-01	Albert & Delores Mussi Trustees	fee title/easement		212.00
233	007-351-05	Steven Mussi	fee title/easement		40.00
234	007-351-06	Marvin & Pat Weathers	fee title/easement		40.00
234a	007-351-07	Marvin & Pat Weathers	fee title/easement		40.00
235	007-351-11	Agnes Buckingham	fee title/easement		128.21
235a	009-421-02	Agnes Buckingham	fee title/easement		188.00
236	007-311-41	Stanley & Ida Lattin	fee title/easement		177.01
237	007-311-03	Peraldo Brothers	fee title/easement		400.00
238	007-311-07	Mario Gene Peraldo	fee title/easement		160.00
239	009-411-49	Frosty Acres M Inc.	fee title/easement		159.17
239a	009-411-48	Frosty Acres M Inc.	fee title/easement		73.24
240	009-411-52	Paul & Marylou Grumstrup	fee title/easement		14.31
241	009-411-26	Samuel Hiibel	fee title/easement		40.00
242	009-411-18	Janet Shupp	fee title/easement		640.00
243	009-411-11	Casey	fee title/easement		640.00
243a	009-411-04	Casey	fee title/easement		674.94
243b	003-711-11	Casey	fee title/easement		484.23
243c	003-711-10	Michael & Claudia Casey	fee title/easement		160.00
243d	003-711-13	Casey	fee title/easement		480.00
243e	003-711-23	Casey	fee title/easement		640.00

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243f	003-711-29	Casey	fee title/easement		480.00
244	009-411-01	Dennis & Catherine Hamlin	fee title/easement		672.26
245	003-711-14	Felipe Obregon	fee title/easement		160.00
246	003-711-30	Jack Montrose	fee title/easement		160.00
247	003-711-02	SantaFe Pacific Gold Corp.	fee title/easement		282.33
248	003-731-06	DLM Properties	fee title/easement		86.44
248a	003-731-07	DLM Properties	fee title/easement		63.89
249	003-731-11	G & A Detomasi/R& K Hammon	fee title/easement		438.20
250	003-731-10	Neil and Georgia Kelly	fee title/easement		160.00
251	003-751-02	Helen Felt	fee title/easement		60.00
252	003-751-03	Robert Boucher	fee title/easement		20.00
252a	003-751-04	Robert Boucher	fee title/easement		40.00
State and County Lands Within Existing Stillwater Wildlife Management Area					
2	003-731-02	State of Nevada	transfer, management agreement, exchange, easement,		48.23
2a	003-711-09	State of Nevada	transfer, management agreement, exchange, easement,		452.21
2b	003-731-03	State of Nevada	transfer, management agreement, exchange, easement,		640.00
2c	003-731-05	State of Nevada	transfer, management agreement, exchange, easement,		279.73
2d	003-731-15	State of Nevada	transfer, management agreement, exchange, easement,		640.00
2i	004-091-23	State of Nevada	transfer, management agreement, exchange, easement,		640.00
3c	004-111-27	Churchill County Trustee	fee title, management agreement, transfer, exchange, easement,		640.00
3d	004-111-29	Churchill County Trustee	fee title, management agreement, transfer, exchange, easement,		640.00
3e	004-111-31	Churchill County Trustee	fee title, management agreement, transfer, exchange, easement,		640.00

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3f	004-311-33	Churchill County Trustee	fee title, management agreement, transfer, exchange, easement,		640.00
3g	003-731-09	Churchill County Trustee	fee title, management agreement, transfer, exchange, easement,		40.00
3h	003-731-13	Churchill County Trustee	fee title, management agreement, transfer, exchange, easement,		636.65
3i	003-731-17	Churchill County Trustee	fee title, management agreement, transfer, exchange, easement,		640.00
3j	003-731-19	Churchill County Trustee	fee title, management agreement, transfer, exchange, easement,		640.00
3k	003-731-22	Churchill County Trustee	fee title, management agreement, transfer, exchange, easement,		640.00
3m	003-391-02	Churchill County Trustee	fee title, management agreement, transfer, exchange, easement,		42.92
3n	003-391-03	Churchill County Trustee	fee title, management agreement, transfer, exchange, easement,		42.92
3p	003-711-21	Churchill County Trustee	fee title, management agreement, transfer, exchange, easement,		400.00
25		State of Nevada	transfer, management agreement, exchange, easement,		640.00

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APPENDIX G:
Public-Use Monitoring Program

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Public Use Monitoring

There is currently a proposal to develop a visitation monitoring program for the Service. This monitoring program is being developed because of the realization that budget allocations are directly tied to visitation; management issues arise when increased visitation begins to impact wildlife and resources; and that a standard method of assessment of visitation will increase integrity of reporting. Public use monitoring, when correlated with biological monitoring provides a basis for determining satisfactory levels of public use with minimum impact on wildlife and habitat. The proposal is being designed to:

"(1) Identify at least three standardized monitoring procedures appropriate to the different types of refuges and management units, and develop a written protocol for the application of each of these procedures.

(2) Develop a plan for the application of the standard monitoring procedures to every refuge and management unit in a timely fashion, in order to acquire data on the number of visitors."

This proposal further specifies that work will be completed by November 30, 2000.

In all current monitoring practices, (the best of those being used by the US Forest Service and the Army Corps of Engineers) there is one consistent theme. That is the use of remote sensing units to detect the movement of visitors, either road or infra-red counters (used to detect individuals on trails).

It is with the above explanation in mind, that Stillwater NWR will adopt the following methods to assess visitation in the assumption that the standard will be utilizing similar strategies.

Stillwater NWR presently employs the use of road counters, so in that light, is fairly up to recent technology. In all likelihood, any protocol developed by Dr. Davis will include the use of remote sensors. Stillwater NWR is also of a fairly simple layout to permit such a method to be used with some degree of accuracy, with only 3 access points open (Alternatives C and D).

A survey is currently underway to assess staff usage. It is assumed this percentage can change monthly or seasonally and is being assessed by staff members reporting for one week a month what road counters they traversed, and how often.

Volunteers (or staff when available) will perform visual observations to determine an average number of individuals per vehicle, as well as collect any incidental information that presents itself and found to be useful to the determination of numbers of visitors. An intensive survey is ongoing each hunting season since the '98-'99 season to determine hunter use, and if staff or volunteer time is available, a similar intensity will continue through the year. This vigorous survey is accomplished by assessing location and number of all the vehicles on the refuge, their location, and if possible, the activity and strategy of the visitor (whether using boat, dog, etc).

In the future, perhaps satellite technology can replace the use of staff time for gathering visitor logistics, but for the time being, visual observations are the best available science.

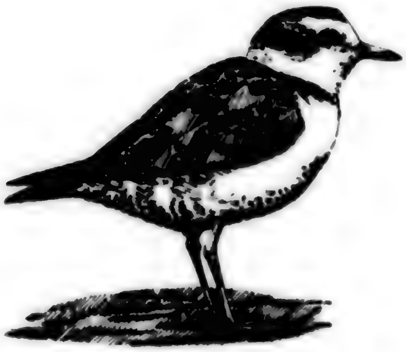
The surveys provide data that can be analyzed to assess density of recreationists. These densities will be used in correlation with biological monitoring efforts to attempt to ascertain the impacts associated with varying levels of activity.

A spreadsheet has been developed to interpret the data collected by the above methods. All the raw data is entered onto the sheet, and calculations are performed, using the extraneous information such as persons per vehicle and staff usage, giving an account that is as accurate as can possibly be developed. The spread sheets will show number of visits, not an assessment of visitor use days or visitor use hours. Additional information will need to be developed to make an assessment of a typical "use day".

With the completion of a visitor's center, head counts of all visitors will be made by docents manning the facility, and a count of all school and interpretive tours will be logged by staff/volunteers with actual group numbers.

The numbers derived from all the above mentioned sources will also provide information to be interpreted as to success of specific programs as well as simply numbers of visitors participating in the programs.

APPENDIX H:
Calculations of Monthly Inflow Volumes



Snowy Plover
by Larry Eifert

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Calculation of Monthly Inflow Volumes of Stillwater Marsh for Alternative Water-Management Strategies of the Stillwater National Wildlife Refuge Complex Comprehensive Conservation Plan and Boundary-Revision Environmental Impact Statement

Prepared by: Don DeLong, U.S. Fish and Wildlife Service
May 1999

The purpose of this report is to provide background information on the monthly Stillwater NWR wetland-inflow volumes of each alternative being evaluated in the environmental impact statement (EIS) being prepared for the Stillwater National Wildlife Refuge (NWR) Complex comprehensive conservation plan and boundary revision. This report explains the basis and assumptions of each alternative seasonal pattern of inflow and outlines the steps used in calculating monthly inflow volumes of deliverable water and incidental flows for each alternative.

The numbers generated on monthly inflow volumes for each alternative were fed into the Stillwater Marsh wetland model (Caplun-Cochrane 1999; Appendix I) and Below Lahontan Reservoir (BLR) model (USBOR 1999). The BLR model was used to estimate potential impacts of alternative wetland water-delivery patterns on various aspects of Newlands Project operations and lower Truckee River and Pyramid Lake hydrology. The Stillwater Marsh wetland model developed by E. Caplun-Cochrane was used to estimate the seasonal fluctuation in wetland-habitat acreage in Stillwater Marsh given differing seasonal wetland inflow patterns and volumes. This report provides the background on the variables for the wetland model. The constants used in the model are described in the in Appendix I.

This report can be used to better understand each alternative's seasonal delivery pattern and can be used in making informed adjustments to seasonal delivery patterns, refining monitoring programs, and for future modeling efforts.

ANNUAL VOLUME OF INFLOW

Three different annual inflow volumes were used for non-spill years: 33,000 acre-feet (AF) (representing 20,000 AF of water rights for Stillwater NWR), 50,000 AF (representing 35,000 AF of acquired water rights and 6,000 AF of groundwater), and 66,000 AF (representing completion of the acquisition program). Two different scenarios were used for spill years: an average spill-volume during February and a relatively large spill during April-June.

The focus of determining a water-delivery pattern was on the full allocation, non-spill year at the completion of the water-rights acquisition program (about 66,000 AF). The 33,000 AF and 50,000 AF delivery patterns were tailored off of the full-allocation year. These two volumes represent stages of the acquisition program, as well as different levels of shortages after completion of the acquisition program (e.g., 50% and 25% shortages, respectively). The full-allocation year is discussed first.

Full Allocation Year at Acquisition-Program Completion

At the completion of the water-rights acquisition program, an estimated 70,000 AF/year of water will be available for use at Stillwater NWR over the long term.

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Spill Year vs. Non-spill Year

Because non-spill years and spill years are so different, these were addressed separately. According to earlier runs of the BLR Model, years of useable spills (when spill-water reaches the wetlands) would occur in 24 of 95 years, or 1 of 4 years (USDOI 1997). Non-spill years would occur in 3 of 4 years.

In a spill year, it is assumed that: (1) the overall volume of water reaching Stillwater NWR would be higher than in a non-spill year, and (2) leasing would not occur.

	Non-spill Year	Spill Year
Deliverable Water		
(Carson Division)	(43,600 AF)	(37,900 AF)
(Segment 7)	(3,500 AF)	(3,500 AF)
Total	47,100 AF	41,400 AF
Drainwater	11,200 AF	11,200 AF
Spill-water	0 AF	22,800 AF
Groundwater	7,725 AF	7,425 AF
	65,725 AF	82,825 AF

Long-term average:

65,725 AF/yr x 3 = 197,175 AF/3yrs
82,825 AF/yr x 1 = 82,825 AF/1yr
280,000 AF/4yrs ÷ 4 = 70,000 AF/yr

This model assumes that Stillwater NWR would receive 56% of water and water rights under the existing water-rights acquisition program for Lahontan Valley. This figure corresponds to the proportion of wetland-habitat to be maintained at Stillwater NWR (14,000 acres, or 56%), of the 25,000-acre total for primary wetland areas in the Lahontan Valley. The following discussion explains the basis of the above numbers.

Inflow Volumes by Source

Drainwater

Drainwater volumes used in the model were obtained from output of a December 1998 run of the BLR model, which calculated drainwater inflows for each alternative based on the differing seasonal pattern of deliveries that would occur under each alternative:

	BLR Model Output			Stillwater's Portion
A.	19,690	x	0.56	≈11,206 AF
B.	19,510	x	0.56	≈10,926 AF
C.	19,370	x	0.56	≈10,847 AF
D.	22,030	x	0.56	≈12,337 AF

These average volumes of drainwater were split between east and west entry points: roughly 60% of the inflow entering through the east side, and 40% entering through the west side (which includes inflow

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from the Canvasback Gun Club). The volume of drainwater entering through the west side was adjusted somewhat to ensure that the level of Lead Lake, in the model, remained at a constant level throughout the year. Thus, the volume of water entering from the west side was the same among alternatives (4,800 AF/year), while the annual volume entering from the east side varied somewhat by alternative.

Spill-water

As with drainwater, the long-term average volumes of useable spills calculated by the BLR Model varied by alternative.

	BLR Model Output	To Obtain Stillwater's Portion:	Volume of Inflow During a Spill Year
A.	10,180 AF/yr x 4 =	40,720 AF/spill-yr (0.56) ≈	22,803 AF/spill-yr
B.	10,880 AF/yr x 4 =	43,520 AF/spill-yr (0.56) ≈	24,371 AF/spill-yr
C.	10,950 AF/yr x 4 =	43,800 AF/spill-yr (0.56) ≈	24,528 AF/spill-yr
D.	9,470 AF/yr x 4 =	37,880 AF/spill-yr (0.56) ≈	21,213 AF/spill-yr

These average volumes of spill-water were split between east and west points of inflow to Stillwater Marsh: 60% of the inflow entering through the east side, and 40% entering through the west side.

Deliverable Water

"Deliverable" water are those water rights that can be called for and delivered to Stillwater NWR at requested periods. It includes all water sources available under the existing water-rights acquisition program, except drainwater, spill-water, and groundwater.

According to the WRAP EIS/ROD, a long-term average of about 77,900 AF of deliverable Carson Division water would flow into the Lahontan Valley wetlands at the completion of the acquisition program. Another 6,200 AF would inflow from the middle Carson River (Segment 7). Stillwater NWR's portion of the above would be 43,700 and 3,500 AF, respectively. For spill-years, leased water was subtracted because water-rights would not be leased during spill-years. Thus, the totals for non-spill-years (3 of 4 years) and spill-years (1 of 4 years) are:

Source	non-spill-year	spill-year
Carson Division	43,600	37,900
Middle Carson River	3,500	3,500
	47,100	41,400

The volume of leased water, an assumed average of 5,700 AF/year in non-spill years, is within a range specified in the WRAP EIS. The WRAP EIS stated that an "average" of 0 to 21,600 AF of water rights would be leased for primary wetlands in the Lahontan Valley (page 2-35). It also stated that as much as 21,600 AF (about 18,300 AF after use-rate conversion) would be leased in 50% of the years, but that "In many years, leasing would contribute less than this amount," and that no leasing would occur in 1/3 of the years. In the remaining 1/6 of the time, it is presumed that substantially less than 18,300 AF would reach the wetlands through leasing. Therefore, in 6 of 9 years, at least some water rights would reach the wetlands through leasing and in some of these years 18,300 AF would reach the wetlands; and in 3 of 9 years, no leasing would occur.

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It was assumed that Stillwater NWR's portion of leased water would be 56%, such that Stillwater NWR's part of the peak lease rate would be 10,250 AF (i.e., 56% of 18,300 AF). Assuming that an average of 7,690 AF (75% of 10,250 AF) would be leased during 50% of the years, the long-term average would be:

10,250(0.75) x ½ ≈ 3,840 AF
10,250(0.25) x 1/6 ≈ 430 AF
0 x 1/3 ≈ 0 AF
4,270 AF

Represented another way:
10,250(0.55) x 3/4 ≈ 4,270 AF (non-spill year in 3 of 4 years)
0 x 1/4 ≈ 0 AF (spill year in 1 of 4 years)
4,270 AF

Assuming a spill frequency of 1 in 4 years, and assuming no leasing during spill years, there would be an average of about 5,700 AF of leased water reaching the wetlands during non-spill years (4,270 x 4 = 17,080, /3 = 5,690). This would require about 6,700 AF to be leased in these years (accounting for the temporary-transfer rate to the wetlands).

For the purposes of this model, it was assumed that all deliverable water would enter the refuge on the east side (e.g., into Stillwater Point Reservoir or from the ST-75 canal).

Groundwater

Groundwater has been viewed as a last resort because of water-quality concerns (USFWS 1996). Therefore, groundwater was used to make up the difference to result in annual volumes needed to achieve a long-term average of 70,000 AF/year for Stillwater NWR, as per the WRAP EIS (USFWS 1996). Therefore, groundwater volume estimates varied somewhat because of differences in drainwater and spill-water among alternatives.

33,000 AF Year

This non-spill year scenario represents long-term averages of 16,000 AF/year of drainwater (under Alternative A) and about 17,000 AF of deliverable water for Stillwater NWR (as a result of acquiring 20,000 AF in the Carson Division). Therefore, it assumes that all water-right transfers that are currently being contested would be made available for wetland deliveries. The drainwater volume for this scenario was estimated using the information graphed in Figure 1, which was derived from drainwater volume estimates of the 1996 run of the BLR model for the WRAP EIS. Drainwater volume for this scenario was held constant among alternatives.

This also roughly depicts what may happen during a severe drought at the completion of the water-rights acquisition program, assuming a 45% water year, about half of the average drainwater volume, full use of groundwater, but only limited ability to lease water rights. The latter assumption conflicts with a major assumption of the water-rights acquisition program (USFWS 1996), that large volumes of water could be leased during drought years, especially during severe droughts.

50,000 AF Year

This non-spill year scenario represents long-term averages of 14,000 AF/year of drainwater, about 30,000 AF of deliverable water for Stillwater NWR (as a result of acquiring 35,000 AF in the Carson Division), and 6,000 AF/year of groundwater. The drainwater volume for this scenario was estimated using the information graphed in Figure 1, which was derived from drainwater volume estimates of the 1996 run of the BLR model for the WRAP EIS. Drainwater volume for this scenario was held constant among alternatives (9,200 AF/year entering from the east side and 4,800 AF/year from the west side).

This also roughly depicts what may happen during an 80% water year at the completion of the water-rights acquisition program, assuming no leased water available, about 80% of the average drainwater volume, and full use of groundwater. Non-use of leased water conflicts with a major assumption of the water-rights acquisition program (USFWS 1996), that large volumes of water could be leased during drought years, especially during severe droughts.

"Average" Spill-year

This spill year scenario depicts what could happen, at the completion of the water-rights acquisition program, given an average-sized spill occurring in February. It assumes that no water would be leased. Therefore, deliverable water is assumed to be 41,400 AF/year. Drainwater and groundwater would be the same as it was under a full-allocation year for each alternative. The total volume of spill-water was split between east and west entry points (roughly 60% and 40%, respectively).

1996 Spill-year

A spill that occurred in 1996 was added as an additional representative year to assess what would happen in a year when a spill occurred later in the year and spread out over several months (March-June). It was not used in calculating long-term average wetland-habitat acreages. This scenario depicts the actual inflow volume and timing of the 1996 spill as applied to a completed water-rights acquisition program. The actual, measured volume of spill-water that flowed into Stillwater NWR during March-June of 1996 (an approximately 35,500 AF) was used in this scenario, as was the proportional splits among months and between east and west entry points. No leased water was used and, therefore, deliverable water totaled 41,400 AF. Drainwater and groundwater would be the same as it was under a full-allocation year for each alternative.

SEASONAL PATTERN OF INFLOW VOLUME

This section of the report describes the pattern of inflow volumes used for each alternative. Most aspects of these seasonal patterns involve decisions by the refuge manager (e.g., when to call for deliverable water, when to pump groundwater). Two components inflow timing are decisions generally outside the decision-making authority of refuge managers. The timing of drainwater inflow is a function of irrigation practices on Carson Division farmlands. Therefore, the same seasonal pattern of drainwater inflow was used for each alternative, and this was held constant among representative water years. Timing of Lahontan Reservoir spills is also outside the control of the refuge manager, although the manager can have some influence on the timing. Spill can occur anytime between November and June. Two different scenarios were used: (1) an average volume of useable spill-water, occurring in February, and (2) 1996 spill-water inflows into Stillwater NWR.

This section first addresses the two components that do not vary among alternatives with respect to seasonal patterns, i.e., drainwater and spill-water, and then describes each alternative's seasonal inflow pattern of deliverable water and groundwater and the basis for these patterns.

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Seasonal Pattern of Drainwater Inflow

The average seasonal pattern of inflow was calculated by averaging the monthly inflows of the Diagonal Drain in 16 non-spill years during 1967-1990. Percent of totals were determined for each month (below) and this was applied to each scenario.

Mon.	%	Mon.	%
Jan	3	Jul	14
Feb	2	Aug	13
Mar	3	Sep	12
Apr	6	Oct	11
May	11	Nov	7
Jun	14	Dec	3
			100

Timing of Spill-water Inflow

The average volume of spill inflow into Stillwater NWR during a spill year is estimated to be approximately 21,213-24,528 AF/spill-year depending on alternative. For the purposes of this report, it was assumed that the spill occurred during February (most spills within the past 20 years have occurred during January and February).

In 1996, spill-water flowed into Stillwater NWR from February 25 through June 17 from several different entry points. These were combined into east and west entry points for the purposes of this report.

Point	March	April	May	June	Total
East	11,410	5,140	3,380	1,070	21,000
West	8,520	2,010	1,330	2,640	14,500
					35,500

Basis of Alternative A's Seasonal Pattern of Inflow Volume

The agricultural seasonal delivery-pattern for the Carson Division was used as the basis for Alternative A's delivery pattern. The Service agreed to order water based on this delivery pattern in the 1996 Water Rights Acquisition EIS/ROD until a comprehensive conservation plan was completed for the Stillwater NWR. To maintain this emphasis on a delivery pattern, the agricultural delivery pattern was also adopted for groundwater pumping. As used in the BLR Model, the following monthly percentages were used:

Month	Monthly Percent
January	0.00%
February	0.00%
March	0.00%
April	11.60%
May	14.40%
June	17.10%
July	18.11%
August	15.19%
September	10.69%
October	6.51%
November	6.40%
December	0.00%
	100.00%

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In spill years, this was adjusted to account for the large influx of spill-water early in the year. Generally, delivery of deliverable water was held off until later in the season. Seasonal pattern of drainwater and groundwater inflow were not adjusted during spill years.

Basis of Alternative B's Season Pattern of Inflow Volume

The pattern of inflow used in Alternative B was one which would maximize the amount of fall/winter wetland habitat. Monthly inflow volumes were identified to produce such an effect. Under this scenario, raising water levels in wetland units would be held off until after the highest period of evapotranspiration (June-August). Beginning later in September, when air temperatures lower and day length shortens sufficiently to reduce evapotranspiration, raising water levels takes less water than it would one or two months prior. Nevertheless, a considerable amount of water would be needed in late summer and early fall to bring wetland units up to desired levels. However, once these levels are reached, maintenance at these levels or slow increases in water level would take relatively little water due to low evapotranspiration rates during November-January. Because peak annual acreage would be maintained during the least costly period, this scenario would require the least amount of water to maintain the targeted annual average wetland-habitat acreage.

Without supplemental inflow, in addition to drainwater, wetland-habitat acreage would begin declining fairly rapidly in May. Therefore, rather than using all of the available deliverable water for the fall and winter period, a portion of water was dedicated for spring use to maintain at least some wetland-habitat through this season. Additional water was dedicated for summer use to maintain some brooding habitat and to start the late summer increase in wetland-habitat acreage at a somewhat higher level.

In spill years, this was adjusted to account for the large influx of spill-water early in the year by "saving" additional water for late summer and fall deliveries. The seasonal pattern of drainwater and groundwater inflow were not adjusted during spill years.

Basis of Alternative D's Season Pattern of Inflow Volume

This alternative's seasonal pattern of inflow mimics the natural hydrologic inflow pattern for Stillwater Marsh. This pattern is being evaluated because one of the fundamental principles of restoring natural biological diversity is to restore ecological processes to their natural level and pattern of operation (Noss and Cooperider 1994, Doppelt et al. 1993). Except in years when floods occurred due to rain on Sierra snowpack between November and April, the seasonal proportion of inflow appears to have been consistent among years under natural conditions. Carson River runoff from April through June consistently accounted for about 40 to 60 percent of the total annual flow (DeLong 1997). During July-September, up to about 10 to 15 percent of the annual flow of the Carson River would have entered the Lahontan Valley wetlands. Inflow from October to December accounted for about 5 to 10 percent of the annual inflow into the Lahontan Valley, and in January to March, inflow would have consistently been about 10 to 20 percent in most nonflood years. Based on the estimated seasonal pattern of inflow, the following percentages were used in the model:

Month	Monthly Percent
January	4.0%
February	4.0%
March	5.0%
April	11.0%
May	33.0%
June	24.0%
July	8.0%
August	2.0%
September	1.5%

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October	1.5%
November	2.0%
December	4.0%
	100.0%

Monthly volumes of deliverable water and groundwater were formulated, taking into account the monthly volume of drainwater, to produce this pattern. Because drainwater volumes in the months of August-October were greater than the volumes "allowed" under this scenario, drainwater volumes were reduced accordingly during August-October and correspondingly increased during November-December. This assumes that drainwater could be stored and released later to accomplish this.

In spill years, the monthly pattern of deliverable-water inflow was adjusted to account for the large influx of spill-water early in the year. They were adjusted in attempt to produce the above percentages, although this was not entirely possible. Seasonal pattern of drainwater and groundwater inflow were not adjusted during spill years.

Basis of Alternative C's Season Pattern of Inflow Volume

Alternative C's pattern of inflow was developed to emphasize a natural seasonal inflow pattern and the associated large volume of fresh water entering the marsh during the spring, using Alternative D's pattern as a starting point, but was modified to minimize nest flooding and to produce more fall/winter wetland habitat than would be produced under Alternative D. The average natural seasonal-inflow pattern (discussed below under Alternative D) formed the basis of this alternative's seasonal inflow pattern. Because the peak water inflow would occur during April-June under Alternative D, peaking in May, extensive nest flooding would occur each year. To alleviate this detrimental affect, the peak-of-flow was moved back to March so that maximum acreages would be obtained before the period of major nest initiation for many wetland bird species (April 1).

Another modification made to the natural seasonal-inflow pattern under this alternative is the increased volume of water that would be shifted to late summer and fall (i.e., shifts the pattern toward Alternative B). There are three reasons for this: (1) under natural conditions, much wetland-habitat would have remained in Stillwater Marsh through the fall and winter in some years (valley-wide, the amount would have been consistently high, even in drought years); (2) Stillwater Marsh is an important stopover and wintering area for many species of waterfowl; and (3) waterfowl hunting is the largest public-use component of Stillwater Marsh and hunters have expressed great interest in the Service providing opportunities for waterfowl hunting. Regarding the first point, Alternative C appears to allow a more representative seasonal pattern of wetland-habitat acres to be sustained than would occur under Alternative D. In this alternative, substantial wetland habitat would be sustained through the fall and winter, but would dedicate a majority of available water to mimicking a spring-time surge in wetland inflow.

In spill years, the monthly inflow of deliverable water was adjusted to account for the large influx of spill-water early in the year. Generally, delivery of deliverable water was held off until later in the season, especially for the 1996 spill-year scenario. Seasonal pattern of drainwater and groundwater inflow were not adjusted during spill years.

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TABLES

Monthly inflow volumes, by source, are presented for each alternative in the following tables.

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FULL ALLOCATION YEAR

ALTERNATIVE A - Full Allocation Year@Buildout (Non-Spill-year)

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			TOTAL INFLOW
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	
Jan.	200	0	0	0	200	150	0	150	350
Feb.	150	0	0	0	150	100	0	100	250
Mar.	200	150	0	0	350	150	0	150	500
Apr.	350	950	0	5,500	6,800	350	0	350	7,150
May	700	1,000	0	6,800	8,500	500	0	500	9,000
Jun.	900	1,250	0	8,000	10,150	700	0	700	10,850
Jul.	900	1,350	0	8,500	10,750	700	0	700	11,450
Aug.	900	1,125	0	7,200	9,225	600	0	600	9,825
Sep.	700	700	0	5,000	6,400	600	0	600	7,000
Oct.	700	450	0	3,100	4,250	500	0	500	4,750
Nov.	500	450	0	3,000	3,950	300	0	300	4,250
Dec.	200	0	0	0	200	150	0	150	350
Total	6,400	7,425	0	47,100	60,925	4,800	0	4,800	65,725

FULL ALLOCATION YEAR

ALTERNATIVE B - Full Allocation Year@Buildout (Non-Spill-year)

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			TOTAL INFLOW
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	
Jan.	200	0	0	0	200	150	0	150	350
Feb.	100	0	0	0	100	100	0	100	200
Mar.	200	400	0	2,100	2,700	150	0	150	2,850
Apr.	300	500	0	3,200	4,000	350	0	350	4,350
May	700	750	0	4,200	5,650	500	0	500	6,150
Jun.	850	900	0	4,600	6,350	700	0	700	7,050
Jul.	850	1,150	0	6,700	8,700	700	0	700	9,400
Aug.	800	1,225	0	8,400	10,425	600	0	600	11,025
Sep.	700	1,150	0	8,400	10,250	600	0	600	10,850
Oct.	700	900	0	5,300	6,900	500	0	500	7,400
Nov.	500	600	0	4,200	5,300	300	0	300	5,600
Dec.	200	150	0	0	350	150	0	150	500
Total	6,100	7,725	0	47,100	60,925	4,800	0	4,800	65,725

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FULL ALLOCATION YEAR

ALTERNATIVE C - Full Allocation Year@Buildout (Non-Spill-year)

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	TOTAL INFLOW
Jan.	200	0	0	700	900	150	0	150	1,050
Feb.	100	100	0	500	700	100	0	100	800
Mar.	200	500	0	13,300	14,000	150	0	150	14,150
Apr.	300	550	0	4,900	5,750	350	0	350	6,100
May	700	850	0	4,600	6,150	500	0	500	6,650
Jun.	850	900	0	4,800	6,550	700	0	700	7,250
Jul.	850	800	0	3,400	5,050	700	0	700	5,750
Aug.	800	650	0	3,400	4,850	600	0	600	5,450
Sep.	700	1,125	0	4,800	6,625	600	0	600	7,225
Oct.	700	1,750	0	3,400	5,850	500	0	500	6,350
Nov.	500	500	0	2,500	3,500	300	0	300	3,800
Dec.	200	0	0	800	1,000	150	0	150	1,150
Total	6,100	7,725	0	47,100	60,925	4,800	0	4,800	65,725

FULL ALLOCATION YEAR

ALTERNATIVE D - Full Allocation Year@Buildout (Non-Spill-year)

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	TOTAL INFLOW
Jan.	250	100	0	2,200	2,550	150	0	150	2,700
Feb.	150	400	0	2,000	2,550	100	0	100	2,650
Mar.	250	500	0	2,400	3,150	150	0	150	3,300
Apr.	450	800	0	5,600	6,850	350	0	350	7,200
May	850	1,625	0	18,700	21,175	500	0	500	21,675
Jun.	1,000	1,250	0	12,800	15,050	700	0	700	15,750
Jul.	1,000	550	0	3,000	4,550	700	0	700	5,250
Aug.	700	0	0	0	700	600	0	600	1,300
Sep.	400	0	0	0	400	600	0	600	1,000
Oct.	500	0	0	0	500	500	0	500	1,000
Nov.	1,000	0	0	0	1,000	300	0	300	1,300
Dec.	950	1,100	0	400	2,450	150	0	150	2,600
Total	7,500	6,325	0	47,100	60,925	4,800	0	4,800	65,725

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35,000 Acre-Feet Acquired (Non-Spill-Year)

ALTERNATIVE A

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			TOTAL INFLOW
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	
Jan.	288	0	0	0	288	150	0	150	438
Feb.	216	0	0	0	216	100	0	100	316
Mar.	288	121	0	0	409	150	0	150	559
Apr.	503	768	0	3,503	4,774	350	0	350	5,124
May	1,006	808	0	4,331	6,145	500	0	500	6,645
Jun.	1,294	1,010	0	5,095	7,399	700	0	700	8,099
Jul.	1,294	1,091	0	5,414	7,798	700	0	700	8,498
Aug.	1,294	909	0	4,586	6,789	600	0	600	7,389
Sep.	1,006	566	0	3,185	4,756	600	0	600	5,356
Oct.	1,006	364	0	1,974	3,344	500	0	500	3,844
Nov.	719	364	0	1,911	2,993	300	0	300	3,293
Dec.	288	0	0	0	288	150	0	150	438
Total	9,200	6,000	0	29,998	45,198	4,800	0	4,800	49,998

35,000 Acre-Feet Acquired (Non-Spill-Year)

ALTERNATIVE B

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			TOTAL INFLOW
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	
Jan.	302	0	0	0	302	150	0	150	452
Feb.	151	0	0	0	151	100	0	100	251
Mar.	302	311	0	1,337	1,950	150	0	150	2,100
Apr.	452	388	0	2,038	2,879	350	0	350	3,229
May	1,056	582	0	2,675	4,313	500	0	500	4,813
Jun.	1,282	699	0	2,930	4,911	700	0	700	5,611
Jul.	1,282	893	0	4,267	6,442	700	0	700	7,142
Aug.	1,207	951	0	5,350	7,508	600	0	600	8,108
Sep.	1,056	893	0	5,350	7,299	600	0	600	7,899
Oct.	1,056	699	0	3,376	5,130	500	0	500	5,630
Nov.	754	466	0	2,675	3,895	300	0	300	4,195
Dec.	302	116	0	0	418	150	0	150	568
Total	9,200	5,999	0	29,998	45,197	4,800	0	4,800	49,997

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35,000 Acre-Feet Acquired (Non-Spill-Year)

ALTERNATIVE C

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	TOTAL INFLOW
Jan.	302	0	0	446	747	150	0	150	897
Feb.	151	78	0	318	547	100	0	100	647
Mar.	302	388	0	8,471	9,161	150	0	150	9,311
Apr.	452	427	0	3,121	4,000	350	0	350	4,350
May	1,056	660	0	2,930	4,646	500	0	500	5,146
Jun.	1,282	699	0	3,057	5,038	700	0	700	5,738
Jul.	1,282	621	0	2,165	4,069	700	0	700	4,769
Aug.	1,207	505	0	2,165	3,877	600	0	600	4,477
Sep.	1,056	874	0	3,057	4,987	600	0	600	5,587
Oct.	1,056	1,359	0	2,165	4,580	500	0	500	5,080
Nov.	754	388	0	1,592	2,735	300	0	300	3,035
Dec.	302	0	0	510	811	150	0	150	961
Total	9,200	5,999	0	29,998	45,197	4,800	0	4,800	49,997

35,000 Acre-Feet Acquired (Non-Spill-Year)

ALTERNATIVE D

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	TOTAL INFLOW
Jan.	307	0	0	1,401	1,708	150	0	150	1,858
Feb.	307	0	0	1,401	1,708	100	0	100	1,808
Mar.	307	0	0	1,401	1,708	150	0	150	1,858
Apr	307	0	0	1,401	1,708	350	0	350	2,058
May	307	0	0	1,401	1,708	500	0	500	2,208
Jun.	307	95	0	1,401	1,803	700	0	700	2,503
Jul.	307	379	0	1,401	2,087	700	0	700	2,787
Aug.	307	474	0	1,401	2,182	600	0	600	2,782
Sep.	307	759	0	1,401	2,467	600	0	600	3,067
Oct.	307	1,541	0	1,401	3,249	500	0	500	3,749
Nov.	307	1,186	0	1,401	2,894	300	0	300	3,194
Dec.	307	522	0	1,401	2,230	150	0	150	2,380
Total	3,680	4,956	0	16,814	25,451	4,800	0	4,800	30,251

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20,000 Acre-Feet Acquired (non-spill-year)

Alternative A

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			TOTAL INFLOW
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	
Jan.	300	0	0	0	300	200	0	200	500
Feb.	200	0	0	0	200	100	0	100	300
Mar.	300	0	0	0	300	200	0	200	500
Apr.	600	0	0	2,000	2,600	400	0	400	3,000
May	1,300	0	0	2,400	3,700	500	0	500	4,200
Jun.	1,500	0	0	2,900	4,400	700	0	700	5,100
Jul.	1,600	0	0	3,100	4,700	700	0	700	5,400
Aug.	1,500	0	0	2,600	4,100	600	0	600	4,700
Sep.	1,300	0	0	1,800	3,100	600	0	600	3,700
Oct.	1,300	0	0	1,100	2,400	500	0	500	2,900
Nov.	800	0	0	1,100	1,900	300	0	300	2,200
Dec.	300	0	0	0	300	200	0	200	500
Total	11,000	0	0	17,000	28,000	5,000	0	5,000	33,000

20,000 Acre-Feet Acquired (non-spill-year)

Alternative B

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			TOTAL INFLOW
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	
Jan.	0	0	0	0	0	0	0	0	0
Feb.	0	0	0	0	0	0	0	0	0
Mar.	0	0	0	750	750	0	0	0	750
Apr.	0	0	0	1,200	1,200	0	0	0	1,200
May	0	0	0	1,500	1,500	0	0	0	1,500
Jun.	0	0	0	1,650	1,650	0	0	0	1,650
Jul.	0	0	0	2,400	2,400	0	0	0	2,400
Aug.	0	0	0	3,000	3,000	0	0	0	3,000
Sep.	0	0	0	3,000	3,000	0	0	0	3,000
Oct.	0	0	0	2,000	2,000	0	0	0	2,000
Nov.	0	0	0	1,500	1.500	0	0	0	1,500
Dec.	0	0	0	0	0	0	0	0	0
Total	0	0	0	17,000	17,000	0	0	0	17,000

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20,000 Acre-Feet Acquired (non-spill-year)

Alternative C

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			TOTAL INFLOW
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	
Jan.	300	0	0	0	300	200	0	200	500
Feb.	200	0	0	0	200	100	0	100	300
Mar.	300	0	0	6,500	6,800	200	0	200	7,000
Apr.	600	0	0	2,100	2,700	400	0	400	3,100
May	1,300	0	0	1,500	2,800	500	0	500	3,300
Jun.	1,500	0	0	1,400	2,900	700	0	700	3,600
Jul.	1,600	0	0	600	2,200	700	0	700	2,900
Aug.	1,500	0	0	600	2,100	600	0	600	2,700
Sep.	1,300	0	0	1,700	3,000	600	0	600	3,600
Oct.	1,300	0	0	1,700	3,000	500	0	500	3,500
Nov.	800	0	0	900	1,700	300	0	300	2,000
Dec.	300	0	0	0	300	200	0	200	500
Total	11,000	0	0	17,000	28,000	5,000	0	5,000	33,000

20,000 Acre-Feet Acquired (non-spill-year)

Alternative D

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			TOTAL INFLOW
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	
Jan.	1,100	0	0	0	1,100	200	0	200	1,300
Feb.	1,200	0	0	0	1,200	200	0	200	1,400
Mar.	900	0	0	500	1,400	200	0	200	1,600
Apr.	600	0	0	2,600	3,200	200	0	200	3,400
May	1,300	0	0	8,200	9,500	200	0	200	9,700
Jun.	1,500	0	0	5,300	6,800	200	0	200	7,000
Jul.	1,600	0	0	400	2,000	200	0	200	2,200
Aug.	900	0	0	0	900	200	0	200	1,100
Sep.	600	0	0	0	600	400	0	400	1,000
Oct.	300	0	0	0	300	300	0	300	600
Nov.	300	0	0	0	300	200	0	200	500
Dec.	1,100	0	0	0	1,100	200	0	200	1,300
Total	11,400	0	0	17,000	28,400	2,700	0	2,700	31,100

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SPILL YEAR

ALTERNATIVE A - Spill Year @ Buildout

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			TOTAL INFLOW
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	
Jan.	200	0	0	0	**200**	150	0	**150**	350
Feb.	150	0	13,700	0	**13,850**	100	9,100	**9,200**	23,050
Mar.	200	150	0	0	**350**	150	0	**150**	500
Apr.	350	950	0	4,800	**6,100**	350	0	**350**	6,450
May	700	1,000	0	6,000	**7,700**	500	0	**500**	8,200
Jun.	900	1,250	0	7,100	**9,250**	700	0	**700**	9,950
Jul.	900	1,350	0	7,500	**9,750**	700	0	**700**	10,450
Aug.	900	1,125	0	6,300	**8,325**	600	0	**600**	8,925
Sep.	700	700	0	4,400	**5,800**	600	0	**600**	6,400
Oct.	700	450	0	2,700	**3,850**	500	0	**500**	4,350
Nov.	500	450	0	2,600	**3,550**	300	0	**300**	3,850
Dec.	200	0	0	0	**200**	150	0	**150**	350
Total	6,400	7,425	13,700	41,400	**68,925**	4,800	9,100	**13,900**	82,825

SPILL YEAR

ALTERNATIVE B- Spill Year @ Buildout

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			TOTAL INFLOW
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	
Jan.	200	0	0	0	**200**	150	0	**150**	350
Feb.	100	0	14,600	0	**14,700**	100	9,800	**9,900**	24,600
Mar.	200	317	0	0	**517**	150	0	**150**	667
Apr.	300	396	0	2,100	**2,796**	350	0	**350**	3,146
May	700	595	0	3,100	**4,395**	500	0	**500**	4,895
Jun.	850	714	0	3,100	**4,664**	700	0	**700**	5,364
Jul.	850	912	0	6,300	**8,062**	700	0	**700**	8,762
Aug.	800	971	0	7,300	**9,071**	600	0	**600**	9,671
Sep.	700	912	0	8,400	**10,012**	600	0	**600**	10,612
Oct.	700	714	0	6,300	**7,714**	500	0	**500**	8,214
Nov.	500	476	0	4,800	**5,776**	300	0	**300**	6,076
Dec.	200	119	0	0	**319**	150	0	**150**	469
Total	6,100	6,126	14,600	41,400	**68,226**	4,800	9,800	**14,600**	82,826

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SPILL YEAR

ALTERNATIVE C - Spill Year @ Buildout

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			TOTAL INFLOW
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	
Jan.	200	0	0	0	200	150	0	150	350
Feb.	100	78	14,700	0	14,878	100	9,800	9,900	24,778
Mar.	200	390	0	4,200	4,790	150	0	150	4,940
Apr.	300	429	0	5,200	5,929	350	0	350	6,279
May	700	663	0	4,700	6,063	500	0	500	6,563
Jun.	850	702	0	4,700	6,252	700	0	700	6,952
Jul.	850	624	0	3,600	5,074	700	0	700	5,774
Aug.	800	507	0	3,600	4,907	600	0	600	5,507
Sep.	700	877	0	5,200	6,777	600	0	600	7,377
Oct.	700	1,365	0	6,300	8,365	500	0	500	8,865
Nov.	500	390	0	3,100	3,990	300	0	300	4,290
Dec.	200	0	0	800	1,000	150	0	150	1,150
Total	6,100	6,025	14,700	41,400	68,225	4,800	9,800	14,600	82,825

SPILL YEAR

ALTERNATIVE D - Spill Year @ Buildout

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			TOTAL INFLOW
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	
Jan.	250	0	0	1,900	2,150	150	0	150	2,300
Feb.	250	0	12,700	0	12,950	150	8,500	8,650	21,600
Mar.	250	0	0	2,200	2,450	150	0	150	2,600
Apr.	250	0	0	5,100	5,350	150	0	150	5,500
May	250	0	0	17,200	17,450	150	0	150	17,600
Jun.	250	0	0	11,700	11,950	150	0	150	12,100
Jul.	250	0	0	2,700	2,950	150	0	150	3,100
Aug.	250	0	0	0	250	150	0	150	400
Sep.	250	0	0	0	250	150	0	150	400
Oct.	250	0	0	0	250	150	0	150	400
Nov.	250	0	0	0	250	150	0	150	400
Dec.	250	125	0	600	975	150	0	150	1,125
Total	3,000	125	12,700	41,400	57,225	1,800	8,500	10,300	67,525

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1996 SPILL

ALTERNATIVE A

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	TOTAL INFLOW
Jan.	200	0	0	0	200	150	0	150	350
Feb.	150	0	0	0	150	100	0	100	250
Mar.	200	150	11,410	0	11,760	150	8,519	8,669	20,429
Apr.	350	950	5,140	0	6,440	350	2,010	2,360	8,800
May	700	1,000	3,380	2,000	7,080	500	1,331	1,831	8,911
Jun.	900	1,250	1,070	5,000	8,220	700	2,640	3,340	11,560
Jul.	900	1,350	0	11,000	13,250	700	0	700	13,950
Aug.	900	1,125	0	9,000	11,025	600	0	600	11,625
Sep.	700	700	0	5,000	6,400	600	0	600	7,000
Oct.	700	450	0	5,000	6,150	500	0	500	6,650
Nov.	500	450	0	4,400	5,350	300	0	300	5,650
Dec	200	0	0	0	200	150	0	150	350
Total	6,400	7,425	21,000	41,400	76,225	4,800	14,500	19,300	95,525

96 SPILL

ALTERNATIVE B

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	TOTAL INFLOW
Jan.	200	0	0	0	200	150	0	150	350
Feb.	100	0	0	0	100	100	0	100	200
Mar.	200	400	11410	0	12,010	150	8519	8,669	20,679
Apr.	300	500	5140	0	5,940	350	2010	2,360	8,300
May	700	750	3380	1,000	5,830	500	1331	1,831	7,661
Jun.	850	900	1070	3,000	5,820	700	2640	3,340	9,160
Jul.	850	1,150	0	7,000	9,000	700	0	700	9,700
Aug.	800	1,225	0	8,000	10,025	600	0	600	10,625
Sep.	700	1,150	0	8,000	9,850	600	0	600	10,450
Oct.	700	900	0	8,000	9,600	500	0	500	10,100
Nov.	500	600	0	6,400	7,500	300	0	300	7,800
Dec.	200	150	0	0	350	150	0	150	500
Total	6,100	7,725	21,000	41,400	76,225	4,800	14,500	19,300	95,525

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SPILL 96

ALTERNATIVE C

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			TOTAL INFLOW
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	
Jan.	200	0	0	0	200	150	0	150	350
Feb	100	100	0	0	200	100	0	100	300
Mar.	200	500	11,410	3,000	15,110	150	8,519	8,669	23,779
Apr	300	550	5,140	1,000	6,990	350	2,010	2,360	9,350
May	700	850	3,380	3,000	7,930	500	1,331	1,831	9,761
Jun	850	900	1,070	4,000	6,820	700	2,640	3,340	10,160
Jul.	850	800	0	7,000	8,650	700	0	700	9,350
Aug.	800	650	0	6,000	7,450	600	0	600	8,050
Sep	700	1,125	0	7,000	8,825	600	0	600	9,425
Oct.	700	1,750	0	6,000	8,450	500	0	500	8,950
Nov.	500	500	0	3,400	4,400	300	0	300	4,700
Dec.	200	0	0	1,000	1,200	150	0	150	1,350
Total	6,100	7,725	21,000	41,400	76,225	4,800	14,500	19,300	95,525

ALTERNATIVE D

	EAST-SIDE INFLOW					WEST-SIDE INFLOW			TOTAL INFLOW
	Drain	Grndwtr	Spill	Deliverable	Total	Drain	Spill	Total	
Jan.	0	400	0	2,200	2,600	100	0	100	2,700
Feb.	150	400	0	2,000	2,550	100	0	100	2,650
Mar.	150	400	0	0	550	100	0	100	650
Apr.	150	400	0	0	550	100	0	100	650
May	150	400	0	9,000	9,550	100	0	100	9,650
Jun.	150	400	0	7,000	7,550	100	0	100	7,650
Jul.	150	400	0	5,000	5,550	100	0	100	5,650
Aug.	1,000	400	0	2,500	3,900	100	0	100	4,000
Sep.	900	400	0	2,500	3,800	100	0	100	3,900
Oct.	800	400	0	3,200	4,400	100	0	100	4,500
Nov.	600	400	0	4,000	5,000	100	0	100	5,100
Dec.	250	400	0	4,000	4,650	100	0	100	4,750
Total	4,450	4,800	0	41,400	50,650	1,200	0	1,200	51,850

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APPENDIX I:
Stillwater Marsh Inflow and Acreage Model

Northern Harrier
by Larry Eifert

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Prototype Stillwater Marsh Model Version 3.1

From: Elizabeth Caplun Cochrane, Consultant

To: Don Delong, Refuge Planner, US Fish and Wildlife Service

CC: Dan Walsworth
Bill Henry
Rob Bundy
Tom Cochrane

Re: Spreadsheet Model of Stillwater Marsh Hydrology - Deliverable:
Prototype Model Version 3.1

Date: May 1, 1999

Hello Don,

Here is the Prototype Version 3.1 of the spreadsheet wetland model for estimating total monthly wetland-habitat acreage on the Stillwater Marsh. It incorporates changes discussed on 11/11/98 and 11/12/98 (flow routes, evapotranspiration rates, volume of Lead Lake, Big Water/Dunes complex), as well as new numbers for water deliveries. Also, it now starts on January 1 instead of October 1. Because of these modifications, results of version 1, 2 and 3 and 3.1 of the model cannot be compared in a meaningful way.

The attached graphs and tables represent four management alternatives currently being considered by refuge staff, under four scenarios: full water year, 20,000 acre-feet acquired, 35,000 acre-feet acquired and spill year. Additional variations are labeled 3.1.1, 3.1.2, and 3.1.3

The attached technical report outlines the assumptions upon which the model was built and incorporates material provided by yourself and other staff members. As discussed in the previous versions of the model, within the limits of confidence in the data and choice of parameters, the model provides valid comparisons, and using the results of the model to compare alternatives, under various water delivery scenarios should provide valid management guidelines.

Opportunities for Further Modeling Development

There are substantial opportunities for developing additional decision-support capabilities for the Stillwater National Wildlife Refuge as an outgrowth of this initial model. The development of database management systems is basic and needed. The complex hydrologic systems and ecology invite the application of both conventional and advanced modeling and computing resources. Also the development of such tools at the Stillwater Marsh could readily be applied to similar management problems nationwide. An advantage of the Stillwater Marsh as the subject for the development of such models is that most of the management decisions are made by a single organization, the US Fish and Wildlife Service. Many other similarly complex hydrologic and environmental systems are managed by a vast complex of organizations, making the development of management tools very difficult. So the Stillwater Marsh situation provides several aspects of a rich opportunity to serve as a laboratory for pushing the state-of-the-art in hydrological and environmental decision-support tools: there is an immediate need for such tools at the refuge; there is an environment that invites the opportunity to develop such tools, and any tools developed lend themselves readily to replication for other national wildlife refuges and other environmental management situations across the country.

1. An examination should be made as to the requirements to make the whole exercise more robust, as for example, what monitoring and baseline data collection are needed. The relationship between water depth, water volume, and surface acreage needs to be better established for each of the water management units. This can be done with proper data quality objectives, a data acquisition program, and a database management system.
2. It may be worthwhile to install extensive instrumentation for one of the units, to provide a more robust data set regarding local hydrologic conditions. This could then be extrapolated to other complexes in the area, perhaps with a relatively limited set of instrumentation requirements for these other units, once the primary influencing factors are better understood.
3. Another aspect that deserves additional work for the model to be used as a planning or management tool is to streamline and improve its interactive features. At this point, all calculations are automated, but the data entry screens could be made more user friendly for the use by somebody less familiar with the model. Improvements could also be made in the methods for updating the bathymetric data driving the acre-feet volume to surface acreage relationship, as knowledge of the physical system is enhanced by field research. In the current generation of the model the equations based on the regression lines are buried too deeply in the software code to be readily modified.
4. It is also worthwhile to examine the flows between complexes to understand maximum flow rates. DU is proposing improvements to the water-conveyance facilities throughout the Stillwater Marsh that promise to substantially improve water flow efficiency by several orders of magnitude. It would be worthwhile to run the prototype model on before-and-after scenarios of their proposals. A collaborative effort appears worthwhile.
5. The Stillwater National Wildlife Refuge is currently engaged in developing an extensive Geographic Information System for the refuge. This provides an opportunity to design data acquisition and database management systems appropriate for use in a shared environment, hence avoiding costly duplication of efforts. Preliminary contacts with ESRI technical staff indicate that the present model can be interfaced with GIS software in order to produce interactive maps of the wetlands under each scenario/alternative.
6. The US Fish and Wildlife Service has extensive nationwide experience in managing wetland environments. It would be worthwhile to perform a literature search to identify other relevant work and model development that has already been accomplished. It is possible that tools have been developed elsewhere which would prove useful for Stillwater NWR, and prevent duplicative efforts.

The MS Excel model is now available on the Stillwater NWR office computers. I will be happy to participate in further modeling development work and analysis.

Thank you very much for the opportunity to participate in this challenging and worthwhile project.

Elizabeth Caplun Cochrane
Information Management Consultant

HYDROLOGY MODEL VERSION 3.1

Technical Report

I. INTRODUCTION:

The Stillwater National Wildlife Refuge is presently drafting an EIS and a Comprehensive Conservation Plan that will provide long term guidance towards achieving its purposes:

- restoring and maintaining natural biological diversity within the refuge;
- conserving and managing fish, wildlife, and their habitat;
- fulfilling international treaty obligations with respect to fish and wildlife; and
- providing opportunities for scientific research, environmental education, and other wildlife-oriented recreation.

Four management alternatives (alternatives A; B; C; D) are considered, each alternative proposing a different schedule of water delivery and identifying a different approach to managing populations and habitat of fish, birds, terrestrial wildlife and plants, recreation, education and interpretation, cultural resources, facilities, law enforcement, etc., in order to sustain a long-term average of 14,000 acres of wetland habitat[1] on the Stillwater National Wildlife Refuge. Each alternative can be implemented under four major scenarios regarding water delivery. Water delivery scenarios take into consideration the total amount of water (acquired water + drain water + groundwater) reaching the Refuge. (See Table 1)

TABLE 1: SUMMARY OF MANAGEMENT ALTERNATIVES AND WATER DELIVERY SCENARIOS

- **4 Scenarios:**

Completed acquisition program	65,000 acre-feet
20,000 acre-feet acquired	33,000 acre-feet
35,000 acre-feet acquired	50,000 acre-feet
Spill Year	80,500 acre feet

-
- **4 Alternatives:**

Focus	Alternative A	Alternative B
Wildlife Management	Key species (waterfowl)	Key species (waterfowl)
Water delivery schedule	Agricultural pattern	Fall emphasis

Focus	Alternative C	Alternative D
Wildlife Management	Natural biodiversity	Natural biodiversity
Water delivery schedule	Modified natural pattern (minimize nests flooding and provide fall/winter habitat for waterfowl and hunting	Natural pattern (mimics the natural hydrologic cycle)

How to evaluate and compare the various combinations of alternatives and water delivery scenarios? More specifically, given the amount of water delivered under each scenario, how to calculate the acreage of wetland corresponding to each alternatives? An Excel spreadsheet was

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chosen as a convenient means of developing a rapid prototype system. This prototype model is a theoretical simplification of a very complex reality. It is not designed to account for all of the parameters that affect the results. However, it provides a decision-support tool for to evaluating alternative water delivery schedule for the Stillwater Marsh.

Previous versions of the model were presented to Refuge Staff during several internal meetings, as well as to Nevada Division of Wildlife (NDOW)[2], to graduate students at the University of Washington, Seattle[3], and to the western section of the Wildlife Society[4]. Model version 3.1 incorporates comments by participants, and in particular suggestions made by Refuge and NDOW staff regarding flow routes, evapotranspiration rates, volume of Lead Lake, addition of Big Water/Dunes Complex . Also, it was decided to start the model on January 1 and to end it on December 31, in order to better estimate the effects of water delivery schedules on fall wetland-habitat.

Within the limitations of the data themselves, this prototype version of the model does show trends and allow meaningful comparisons among and within the four alternatives, under the various scenarios: yearly and monthly average acreage of wetlands, seasonal peaks and lows, and a general indication of where the water is within the marsh system. It can also be used to help determine where to store water with the maximum impact on total acreage.

II. DESIGN ASSUMPTIONS

All versions of this model were built according to the following assumptions:

1. The prototype model considers simplified flow patterns through hydrologic complexes, each complex representing one or several bodies of water. This choice was made to keep the model from becoming too unwieldy.
2. The prototype model ignores the effect of precipitation and groundwater infiltration on the amount of water available, as well as other factors potentially affecting evapotranspiration (ET), such as weather, vegetation type and cover, and Total Dissolved Solids (TDS).
3. The prototype model assumes two major delivery channels to the marshes: on the east side, a combined Diagonal/S-Line feeding into Stillwater Point Reservoir Complex, and on the west side, the Paiute Drain feeding into Lead Lake.
4. The prototype model ignores the effects on water flows of the channels, canals and control structures between bodies of water. It assumes water travels "instantaneously" from one complex to the next.
5. Because of the paramount effect of evapotranspiration, deciding to treat the amount water as if it was delivered at the beginning, at the middle or at the end of the month would have produced very different results. Hence, the prototype model uses daily flow rates and daily evapotranspiration rates, *i.e.* assumes that water delivered by the Diagonal/S-line and the Paiute Drain is evenly distributed over the duration of the month, and accounts for evapotranspiration on a daily basis. This approach also minimizes the issue raised in point 4. above, since it considers water deliveries as daily increments.
6. The model uses a sequence of calculations for each day (Figure 1), with the final volume and acreage being used as the initial volume and acreage for the following day. The equations driving the model are as follow:

a) Initial Volume: unless specified otherwise, the model assumes that starting volume of each complex on the first day of the water year is the same as on the last day. This is referred to as "steady state" and implies that the same combination of scenario-alternative will apply year after year. The model adjusts the values automatically through reiterations

b) Initial Volume (acre-feet) to Initial Acreage (acres): see separate discussion below

c) Inflow (acre-feet): amount of water (acre-feet) delivered daily to a particular complex by the previous complex(es) (outflow from that complex) or the feeding channel. Equals the number of acre-feet for a given month divided by the number of days in that month.

d) New Volume: initial volume (acre-feet) + inflow (acre-feet)

e) Outflow: amount of water flowing out of a complex daily once the volume of water in that complex reaches a given level. This amount becomes the inflow into the next complex. A figure corresponding to the volume triggering outflow was provided by the Stillwater NWR staff for each complex (see Table 3 below). Outflow stops when the volume goes back to its trigger value or below.

f) Resulting Volume (acre-feet): New volume (acre-feet) - outflow (acre-feet).). Resulting volume is always equal or greater than zero (no negative values are allowed in this cell).

g) New Acreage (acres): see separate discussion below

h) Evapotranspiration (acre-feet): new acreage (acres) x evapotranspiration rate (feet/day) (see Table 2: Evapotranspiration Rates).

i) Final Volume (acre-feet): resulting volume (acre-feet) - evapotranspiration (acre-feet). Resulting volume is always equal or greater than zero (no negative values are allowed in this cell). The volume of a complex at the end of one day is automatically transposed as the initial volume of the complex for the following day. Under the "steady state" assumption, this value on the last day (Dec. 31) is the same as the starting volume on day one (Jan. 1).

j) Final Acreage (acres): see separate discussion below. The acreage of a complex at the end of one day is automatically transposed as the initial acreage of the complex for the following day.

FIGURE 1: SEQUENCE OF CALCULATIONS

Initial Volume (acre-feet) --> Initial acreage --> Inflow (acre-feet per day) --> New volume (acre-feet) --> Outflow (acre-feet) --> Resulting Volume (acre-feet) --> New acreage --> Evapotranspiration (acre-feet) --> Final volume (acre-feet) --> Final acreage (Acres)

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III. CONSTANTS.

The flow route, the volume-to-acreage relationships and the evapotranspiration rates are identical throughout the model, for each scenario-alternative combination. This section describes briefly how these values were obtained.

1. Evapotranspiration:

The rates used in the present model are based on several sets of data: data compiled by Sutherland in 1957 covering 1906-1955, including evapotranspiration estimates for emergent marsh, and data from a pan evaporation study performed in Stillwater and covering 1993-1997. The present model uses the emergent marsh estimates, adjusted by a factor representing the quotient between the monthly averages calculated from the Stillwater study and those calculated from Sutherland study (see Table 2).

TABLE 2: EVAPOTRANSPIRATION RATES

	Inches	Feet	Feet per day
Jan	1.70	0.14	0.005
Feb	1.30	0.11	0.004
Mar	1.40	0.12	0.004
Apr	4.00	0.33	0.011
May	7.20	0.60	0.019
Jun	7.90	0.66	0.022
Jul	11.70	0.98	0.031
Aug	9.50	0.79	0.026
Sep	7.10	0.59	0.020
Oct	4.90	0.41	0.013
Nov	2.50	0.21	0.007
Dec	1.20	0.10	0.003
TOTAL	**60.40**	**5.03**	

Sources: Sutherland 1957
1993-1997 Pan evaporation study, Stillwater

2. Volume - Acreage Relationships

Because the acreage of wetland created by a given amount of water depends on the topography of the complexes — deep basins create less wetland acreage than shallow basins with the same volume of water — the model uses an equation representing the relationship between volume and acreage for each complex. This equation lies at the core of the model and allows to calculate the acreage corresponding to the volume each complex at different stages (before and after inflow and outflow, before and after evapotranspiration. This is also particularly important because the amount of water lost through evaporation is proportional to the surface area of the complex (for a given volume of water, the larger the surface area, the larger the quantity of water lost by evapotranspiration)

For each complex, the Stillwater NWR staff provided a table showing volume and acreage at 3 inch interval of incremental depth. Data was based on actual measurements, observations, best estimates and deductive reasoning. Volume (x axis) and acreage (y axis) were plotted and the

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resulting curve was fitted with a regression curve. Table 3 presents the equations associated with the regression curves, the confidence values (R^2), as well as the volumes triggering outflow.

TABLE 3: VOLUME TO ACREAGE RELATIONSHIPS AND OPTIMUM VOLUME OF EACH COMPLEX

Unit	Equation y =	R2	Trigger Volume (acre-feet)
Stillwater Point Res.	$69.723x^{0.4085}$	0.9906	3,608
Foxtail Lake Complex	$(-0.0002x^2)+ 1.1078x + 147.33$	0.9778	2,559
Division Rd. Complex	$(-0.0003x^2) + 1.0239x + 115.54$	0.9837	1,838
East Alkali Lake Complex	$121.01\mathrm{Ln}(x) - 261.14$	0.9745	878
Goose Lake Complex	$41.59x^{0.4412}$	0.9975	1,807
Nutgrass Lake/Swan Check Complex	$170.64x^{0.3555}$	0.9995	5,363
Lead Lake	$(-0.0002x^2)+0.8711x+116.99$	0.9851	475
West Marsh/Willow Complex	$139.33x^{0.3556}$	0.9964	5,103
Tule Lake Complex	$101.51x^{0.3548}$	0.9917	2,584
Swan Lake Complex	$68.295x^{0.3986}$	0.9978	2,853
Pintail Lake Complex	$178.43x^{0.2762}$	0.9961	2,486
Big Water/Dunes Complex	$450.35x^{0.3197}$	0.9998	6,750

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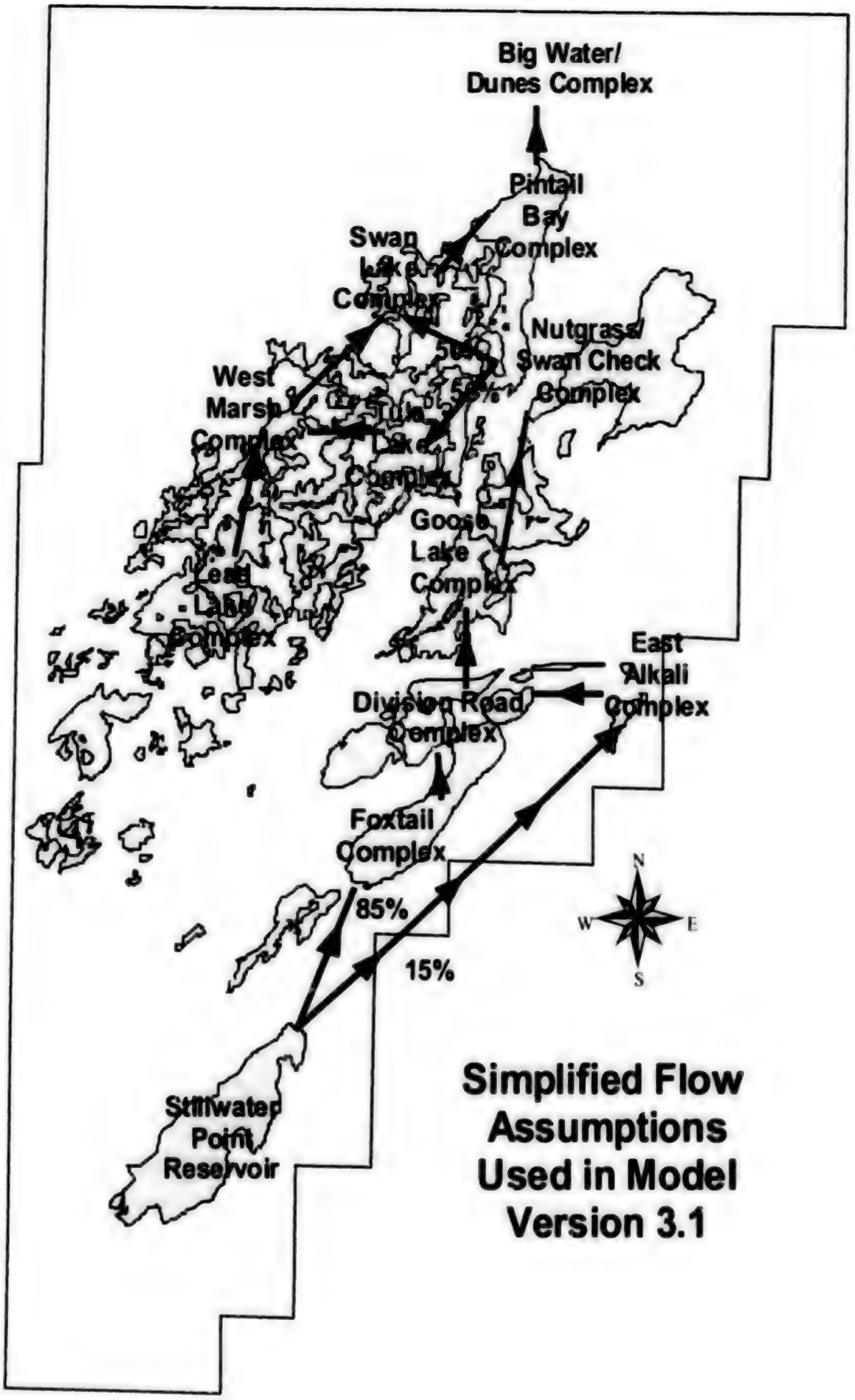
3. Flow routes in Model Version 3.1

The model assumes the following flow patterns described in Figure 2:

FIGURE 2: FLOW ROUTES



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A. [Diagonal/S line] Stillwater Point Reservoir --> (1) 85% Foxtail Lake Complex, (2) 15% East Alkali Lake Complex --> Division Rd. Complex --> Goose Lake Complex --> Nutgrass/Swan Check Complex (1) 50%--> Tule Lake Complex --> West Marsh Complex, (2) 50%--> Swan Lake Complex --> Pintail Lake Complex --> Dunes/Big Water

B. [Paiute Drain] Lead Lake --> West Marsh Complex --.> Swan Lake Complex

a) Outflow of one complex can feed into more than one subsequent complex (i.e. from Stillwater Point reservoir into Foxtail Lake and East Alkali Lake complexes, from Nutgrass Lake complex into Tule Lake and Swan Lake complexes).

b) Conversely, one complex can be fed by more than one "upstream" complex (i.e. Tule Lake Complex and Lead Lake feed into West Marsh complex; Nutgrass Lake and West Marsh Complexes feed into Swan lake Complex)

c) Outflow from one complex to a subsequent complex is triggered when the volume (initial volume + inflow) is greater than the "trigger" volume, as estimated by USFWS staff (see Table 3 above).

d) The routes used in this version 3.1 were chosen by the Stillwater NWR staff, taking into accounts comments made during internal meetings and a meeting with the NDOW staff. The model assumes that the outflow of Tule Lake Complex goes into West Marsh Complex. This assumption describes one possible situation, while not necessarily the situation prevailing under existing conditions.

e) For the purpose of this model, it is assumed that all the wetland acreage created by the Big Water/Dunes Complex counts towards the legally mandated average of 14,000 acres

IV. VARIABLES

The model compares how different annual amounts of water (water delivery scenarios), under different delivery schedule (alternatives) translate into acreage of wetlands. Each water delivery scenarios is run under the four alternatives (A, B, C, D) being considered.

1. Note about Spill Year vs. Non-spill Year

According to the Bureau of Land Reclamation, years of useable spill (when spill water reaches the wetlands) would occur in 24 of 95 years , or 1 of 4 years (USDOI 1997)[5] . During a spill year, the overall volume of water reaching the Stillwater NWR would be higher and leasing would not occur.

2. Annual Volume of Inflow

a) Full Allocation Year at Acquisition-Program Completion
At the completion of the water right acquisition program, an estimated 70,000 acre-feet/year of water will be available for use at Stillwater NWR over the long term (taking into account one spill year in four years):

TABLE 4: COMPLETED ACQUISITION PROGRAM DURING SPILL AND NON-SPILL YEARS

Completion of Acquisition Program	Non-spill Year (acre-feet/year.)	Spill Year (acre-feet/year.)
Deliverable water	47,100	41,400
Drain water	12,200	12,200
Spill-water	0	2,800
Groundwater	7,725	7,425
	65,725	82,825

TABLE 5: INFLOW VOLUME BY SOURCE - COMPLETED ACQUISITION PROGRAM

	A	B	C	D
Deliverable water	47,100	47,100	47,100	47,100
Drain water	11,206	10,926	10,847	12,337
Spill-water (when applicable)	22,803	24,371	24,528	21,213
Groundwater	7,725	7,725	7,725	7,725

Table 5 show that spill water and drain water volumes vary by alternatives. Groundwater is used to make up the difference, in order to reach the volumes needed to achieve the long term-average on 70,000 acre-feet/year for Stillwater NWR, as per WRAP EIS (USFWS 1996[6])

Deliverable water corresponds to those water rights that can be called for and delivered to Stillwater NWR at requested periods. It includes an assumed average of 5,700 acre-feet/year of leased water in non-spill years. This amount would be subtracted during spill years.

The model considers two main water delivery channels (see Table 6):

- East Side: Diagonal/S line feeding into Stillwater Point Reservoir.
- West Side: Paiute Drain feeding into Lead Lake. The west side includes inflow from the Canvasback Gun Club. The volume of drain water entering from the east side was adjusted somewhat to ensure that the level of Lead Lake remains constant throughout the year

TABLE 6: ENTRY POINT INTO THE STILLWATER NWR

	East Side	West Side
Deliverable water	100%	0%
Drain water	60%	40%
Spill-water (when applicable)	60%	40%

b) 33,000 Acre-feet Year

This non-spill scenario represents about 17,000 acre-feet/year of deliverable water to Stillwater NWR (20,000 acre-feet acquired), plus long-term averages of 16,000 acre-feet/year of drain water. Drain water volume for this scenario was held constant among alternatives.

This also roughly depicts what may happen during a severe drought at completion of the water rights acquisition program, assuming a 45% water year: water available will comprise about half of the drain water volume, full use of groundwater, but only limited ability to lease water rights. The latter assumption conflicts with a major assumption of the water right acquisition program (USFWS, 1996), according to which large volumes of water could be leased during drought years.

c) 50,000 Acre-feet Year

This non-spill scenario represents about 30,000 acre-feet/year of deliverable water to Stillwater NWR (35,000 acre-feet acquired), plus long-term averages of 14,000 acre-feet/year of drain water. Drain water volume for this scenario was held constant among alternatives. This scenario also considers the availability of 6,000 acre-feet of groundwater.

This also roughly depicts what may happen at completion of the water rights acquisition program, assuming a 80% water year: water available will comprise about 80% of the drain water volume, full use of groundwater, without the ability to lease water rights. The latter assumption conflicts with a major assumption of the water right acquisition program (USFWS, 1996), according to which large volumes of water could be leased during drought years.

d) "Average" Spill Year

This scenario depicts what would happen at completion of the water rights acquisition program, given an average-size spill occurring in February. It assumes that no water will be leased, hence reducing deliverable water to 41,400 acre-feet/year. Drain water and groundwater would be the same as it was under a full allocation year, under each alternative.

e) 1996 Spill Year

This scenario depicts the actual inflow volume and timing of the 1996 spill, as applied to a completed water rights acquisition program. The actual, measured volume of spill water that flowed into Stillwater NWR during March-June 1996 was approximately 35,000 acre-feet. No leased water was used. Deliverable water amounted to 41,400 acre-feet. Drain water and groundwater would be the same as it was under a full allocation year, under each alternative.

3. Seasonal Timing of Inflow

a) Seasonal pattern of drain water:

Timing of drain water inflow is a function of irrigation practices on Carson Division Farmlands. The average seasonal pattern was calculated by averaging the monthly inflows of the Diagonal Drain (east side) during 16 non-spill years during 1967-1990. Percent of totals were determined for each month (below) and this was applied to each scenario:

Month	**%**	**Month**	**%**	**Month**	**%**	**Month**	**%**
Jan	3	Apr	6	Jul	14	Oct	11
Feb	2	May	11	Aug	13	Nov	7
Mar	3	Jun	14	Sep	12	Dec	3

b) Seasonal pattern of spill water:

Spill can occur anytime between November and June. For the "Average Spill" scenario, it was assumed that the spill occurred in February (most spills during the past twenty years have occurred during January and February).

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In 1996, spill water flowed into Stillwater NWR from February 25 through June 16, from different entry points. For the purpose of this model, these were combined into east and west sides:

Side	March	April	May	June	Total
East (acre-feet)	11,410	5,140	3,380	1,070	21,000
West (acre-feet)	8,520	2,010	1,330	2,640	14,500
Total acre-feet					35,000

c) Seasonal patterns adopted in each alternatives

- Alternative A: based on agricultural pattern for the Carson Division. During spill years, this was adjusted to account of the large influx of spill water early in the year. Seasonal patterns of drain water and ground water inflow were not adjusted during spill years.
- Alternative B: chosen to maximize the amount of fall/winter habitat. A portion of water was dedicated for spring use to maintain at least some wetland habitat at this season. Additional water was used in the summer to maintain brooding habitat and to start the late summer increase in wetland habitat acreage at a somewhat higher level. During spill years, some water was "saved" for late summer and fall deliveries. Seasonal patterns of drain water and groundwater were not adjusted.
- Alternative C: modified natural seasonal inflow pattern. Chosen to emphasize a natural seasonal inflow pattern and the associated large volume of fresh water entering the marsh during the spring, while minimizing nest flooding and providing more fall/winter habitat than would be produced by unaltered natural inflow patterns. In spill years, the monthly inflow of deliverable water was adjusted to account for the large amount of water reaching Stillwater NWR early in the year. Deliverable water was held off until later in the season, especially for the 1996 spill year scenario. Seasonal patterns of drain water and groundwater were not adjusted for spill years
- Alternative D: mimics the natural hydrologic inflow pattern. Except in years when floods occurred due to rain on Sierra snowpack between November and April, the majority of the water (68 per cent) reaches Stillwater NWR during April-June. Inflow of deliverable water and groundwater were tailored to produce this pattern. Because drain water volumes in August-October were greater that the volumes "allowed" under this scenario, they were reduced during these months and increased accordingly during November-December. This assumes that drain water could be stored for later use. In spill years, the monthly pattern was adjusted to account for the large amount of water reaching Stillwater NWR early in the year. Seasonal patterns of drain water and groundwater were not adjusted.

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V. MODEL OUTPUT

TABLE 7: OVERVIEW OF HYDROLOGY MODEL VERSION 3.1

Version	Water Delivery Scenarios	Starting Volume and Acreage
3.1.0	20,000 acquired 35,000 acquired Completed acquisition program	"Steady State Hypothesis": the starting volume and acreage on day 1 are automatically adjusted to match the final volume and acreage on the last day of the year.
	Spill Year	assuming same starting acreage as determined by Completed acquisition program 3.1.0. No automatic adjustment
3.1.1	20,000 acquired	assuming 10,000 acres of wetland as the starting point on day 1. No automatic adjustment
3.1.2	Spill Year 1996: Using the amount of water actually delivered to the Refuge in 1996	assuming same starting acreage as determined by Completed acquisition program 3.1.0. No automatic adjustment
3.1.3	Full Allocation following spill year	assuming same starting acreage as determined by Spill Year 1996 3.1.2. No automatic adjustment

1. The attached graphs and tables show how each scenario/alternative combination translate into monthly acreage.
2. Within each scenario, all four management alternatives are based on the same model structure. The only variables entered manually were
   a) the monthly water inflow
   b) starting volumes, in absence of automatic adjustment (see Table 7)
3. The uncertainties regarding the available data make the absolute values uncertain. However, within the limits of confidence in the data and choice of parameters, the model provides valid comparisons, and using the results of the model to compare alternatives, under various water delivery scenarios should provide valid management guidelines.

VI. DISCUSSION

1. ***Is the tool appropriate for the task?*** The present modeling effort is a first step towards introducing computer-based tools into the planning and management process at Stillwater National Wildlife Refuge. The choice of a spreadsheet model was particularly appropriate to the situation , which called for using the simplest possible tool in order to establish valid trend comparisons. Given the type of data available and their level of accuracy, a more sophisticated approach would not have produced more reliable results, i.e. would not have made the absolute values more reliable. Furthermore, the process of creating the model — from deciding on how to cluster the marshes into "complexes" to adopting a particular flow route — was in itself a valuable exercise, which revealed gaps in data, and pointed towards a greater discipline in data collection and management.

2. ***How are inflow and outflow handled by the model?*** The model assumes that each complex behaves like a cup that overflows once full. It assumes arbitrarily that inflow arrives instantaneously each day, which brings the water level to a certain level. If this level brings the water to the "rim of the cup", it overflows at once into the next complex. Evapotranspiration calculation is based on the acreage corresponding to the volume of water after outflow. In reality, one can expect a continuous adjustment of the water level within each complex , as opposed to the sudden changes contrived by the model. However, by running the model on a daily basis, as opposed to a monthly basis for example, one minimizes the distortion introduced by this simplification.

3. ***How sensitive is the model?*** At the core of the model is the relationship between depth, volume and surface area for each of the complexes. Based on bathymetric data provided by staff, regression curves linking volume (x axis) and acreage (y axis) were built for each complex, whose equations drove the calculation of the surface area corresponding to the volume of water present in the complexes after inflow and outflow. The regression lines do not go through the intersection at 0. Instead, it was decided to make them fit the data points, which start with the volume and surface area corresponding to a depth of 0.25 ft depth and are given at 0.25 ft intervals, in order to get the best possible relationship between volume and acreage when there is water in the complex. The amount of water lost by evaportranspiration is determined by the surface area. Given the importance of evapotranspiration as the only flow out of the marsh system, the accuracy of the model is limited by the accuracy of the data describing this relationship.

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[1] See Title II, Section 206, Public Law 101-618 (Federal Register reference???). Specifically, subsection 206(a) directs the Secretary of Interior to acquire enough water and water rights in conjunction with the State of Nevada and other parties, to sustain a long-term average of 25,000 acres of primary wetland habitat in the Lahontan Valley. Of the 25,000 acre target, an average of about 14,000 would be sustained over the long term on Stillwater NWR.

[2] November 11 and 12, 1998

[3] E. Caplun Cochrane: "Modeling the wetlands of the Stillwater National Wildlife Refuge", Jan. 6, 1999, Silviculture Laboratory Seminar, College of Forest Resources, University of Washington, Seattle

[4] E. Caplun Cochrane, T. Cochrane: "Integrating Modeling Tools in the Planning Process: the Example of Wetlands, Stillwater National Wildlife Refuge", Comprehensive Conservation Planning on National Wildlife Refuges, The Wildlife Society, Western Section, Jan. 21-24, 1999, Monterey, California

[5] USDOI 1997

[6] Final Environmental Impact Statement For Water Rights Acquisition for Lahontan Valley Wetlands

Summary

FULL	INFLOW				ACREAGE			
v3.1.0	A	B	C	D	Total A	Total B	Total C	Total D
Jan.	350	350	1,050	2,700	13,025	16,064	11,044	5,869
Feb.	250	200	800	2,650	12,588	15,593	10,860	6,692
Mar.	500	2,850	14,150	3,300	12,235	15,394	15,059	8,224
Apr.	7,150	4,350	6,100	7,200	12,232	15,193	18,787	10,505
May	9,000	6,150	6,650	21,675	12,762	13,837	17,189	15,791
Jun.	10,850	7,050	7,250	15,750	13,500	12,550	16,111	21,172
Jul.	11,450	9,400	5,750	5,250	13,108	10,671	13,530	17,017
Aug.	9,825	11,025	5,450	1,300	12,683	10,914	9,314	13,129
Sep.	7,000	10,850	7,225	1,000	12,386	12,678	8,574	8,373
Oct.	4,750	7,400	6,350	1,000	12,610	14,029	10,137	5,174
Nov.	4,250	5,600	3,800	1,300	13,043	15,818	10,854	4,228
Dec.	350	500	1,150	2,600	13,354	16,455	11,118	4,723
Total	65,725	65,725	65,725	65,725	12,794	14,100	12,715	10,075

35,000 Acre-Feet Acquired (Non-Spill-Year)

v3.1.0	INFLOW				ACREAGE			
	A	B	C	D	Total A	Total B	Total C	Total D
Jan.	438	452	897	1,953	10,059	12,244	9,815	5,458
Feb.	316	251	647	1,937	9,740	11,778	9,542	6,058
Mar.	559	2,100	9,311	2,460	9,497	11,504	11,629	6,753
Apr.	5,124	3,229	4,350	5,228	9,466	10,944	13,772	8,663
May	6,645	4,813	5,146	14,994	9,779	10,046	13,039	11,865
Jun.	8,099	5,611	5,738	11,265	10,257	9,701	12,143	14,410
Jul.	8,498	7,142	4,769	4,359	9,815	8,451	9,521	13,136
Aug.	7,389	8,108	4,477	1,459	9,451	8,485	6,898	9,749
Sep.	5,356	7,899	5,587	1,091	9,350	9,479	6,366	6,531
Oct.	3,844	5,630	5,080	1,113	9,675	10,565	8,019	4,195
Nov.	3,293	4,195	3,035	1,527	10,042	11,560	9,629	3,669
Dec.	438	568	961	2,614	10,278	12,585	9,953	4,562
Total	49,998	49,997	49,997	49,998	9,784	10,612	10,027	7,921

SPILL	INFLOW				ACREAGE			
v3.1.0	A	B	C	D	Total A	Total B	Total C	Total D
Jan.	350	350	350	2,425	13,023	16,064	10,992	5,802
Feb.	23,050	24,600	24,778	21,951	18,768	21,835	18,481	12,361
Mar.	500	667	4,940	3,227	25,349	25,354	25,678	18,072
Apr.	6,450	3,146	6,279	6,902	24,555	24,184	25,246	19,768
May	8,200	4,895	6,563	20,586	22,560	21,377	23,250	23,912
Jun.	9,950	5,364	6,952	14,966	17,922	15,591	18,334	25,063
Jul.	10,450	8,762	5,774	5,089	15,767	12,001	14,024	21,056
Aug.	8,925	9,671	5,507	1,300	13,553	10,239	10,033	13,078
Sep.	6,400	10,612	7,377	1,000	12,001	11,093	8,747	8,309
Oct.	4,350	8,214	8,865	1,000	11,628	13,570	10,745	5,109
Nov.	3,850	6,076	4,290	1,300	12,143	15,146	13,043	4,178
Dec.	350	469	1,150	3,078	12,742	16,246	13,430	4,863
Total	82,825	82,825	82,825	82,825	16,668	16,892	16,000	13,464

20,000 Acre-Feet Acquired (non-spill-year) **Steady state hypothesis**

v3.1.0	INFLOW				ACREAGE			
	A	B	C	D	Total A	Total B	Total C	Total D
Jan.	500	500	500	1300	7,177	7,764	6,173	3,620
Feb.	300	300	300	1300	7,028	7,478	6,018	4,408
Mar.	500	1250	7000	1600	6,920	7,463	7,790	5,084
Apr.	3000	2200	3100	3600	6,886	7,414	10,135	5,706
May	4200	3300	3300	10000	6,544	6,903	9,247	7,958
Jun.	5100	3850	3600	7500	6,775	6,571	7,685	10,055
Jul.	5400	4700	2900	2700	6,295	5,600	5,734	8,702
Aug.	4700	5100	2700	1500	5,832	5,365	4,390	5,656
Sep.	3700	4900	3600	1000	5,844	5,922	4,457	3,465
Oct.	2900	3800	3500	600	6,276	6,954	5,224	2,950
Nov.	2200	2600	2000	600	6,894	7,499	5,912	2,976
Dec.	500	500	500	1300	7,189	8,319	6,197	3,285
Total	33,000	33,000	33,000	33,000	6,638	6,938	6,580	5,322

20,000 Acre-Feet Acquired (non-spill-year) **10,000 acres on Jan.1 hypothesis**

v.3.1.1	INFLOW				ACREAGE			
	A	B	C	D	Total A	Total B	Total C	Total D
Jan.	500	500	500	1300	9,581	9,581	9,581	9,894
Feb.	300	300	300	1300	8,657	8,657	8,657	9,504
Mar.	500	1250	7000	1600	7,822	8,183	9,495	9,067
Apr.	3000	2200	3100	3600	7,279	7,459	10,357	8,489
May	4200	3300	3300	10000	5,659	5,440	8,500	8,967
Jun.	5100	3850	3600	7500	5,881	5,102	6,917	10,309
Jul.	5400	4700	2900	2700	5,612	4,742	5,734	8,954
Aug.	4700	5100	2700	1500	5,527	5,018	4,390	6,139
Sep.	3700	4900	3600	1000	5,761	5,720	4,457	3,465
Oct.	2900	3800	3500	600	6,172	6,802	5,224	2,950
Nov.	2200	2600	2000	600	6,650	7,327	5,912	2,976
Dec.	500	500	500	1300	7,053	7,574	6,197	3,285
Total	33,000	33,000	33,000	33,000	6,804	6,800	7,118	7,000

SPILL 96	INFLOW				ACREAGE			
v.3.1.2	A	B	C	D	Total A	Total B	Total C	Total D
Jan.	350	350	350	2,700	13,023	16,064	10,992	5,869
Feb.	250	200	300	2,650	12,587	15,593	10,711	6,692
Mar.	20,429	20,679	23,779	20,829	17,078	20,215	17,558	13,343
Apr.	8,800	8,300	9,350	8,750	24,461	25,589	25,534	21,181
May	8,911	7,661	9,761	16,686	23,268	24,239	24,609	23,552
Jun.	11,560	9,160	10,160	13,660	19,056	20,682	21,620	23,565
Jul.	13,950	9,700	9,350	7,250	17,211	15,473	16,262	18,397
Aug.	11,625	10,625	8,050	4,100	16,298	13,526	13,842	14,076
Sep.	7,000	10,450	9,425	4,000	14,598	13,790	12,797	10,467
Oct.	6,650	10,100	8,950	4,500	14,717	15,562	14,351	8,188
Nov.	5,650	7,800	4,700	4,900	15,782	17,901	15,408	10,093
Dec.	350	500	1,350	5,500	16,436	20,125	16,060	11,987
Total	95,525	95,525	95,525	95,525	17,043	18,230	16,645	13,951

FULL FOLLOWING SPILL 96
v.3.1.3

	INFLOW				ACREAGE			
	A	B	C	D	Total A	Total B	Total C	Total D
Jan.	350	350	1,050	2,700	16,026	17,955	15,785	13,785
Feb.	250	200	800	2,650	15,542	16,834	15,395	14,062
Mar.	500	2,850	14,150	3,300	15,345	16,670	19,288	14,413
Apr.	7,150	4,350	6,100	7,200	15,122	16,564	23,378	15,974
May	9,000	6,150	6,650	21,675	13,756	15,740	19,986	20,965
Jun.	10,850	7,050	7,250	15,750	12,540	14,279	16,583	24,107
Jul.	11,450	9,400	5,750	5,250	10,650	11,350	14,110	19,747
Aug.	9,825	11,025	5,450	1,300	10,865	10,914	10,133	13,129
Sep.	7,000	10,850	7,225	1,000	12,667	12,678	8,728	8,373
Oct.	4,750	7,400	6,350	1,000	14,023	14,029	10,150	5,174
Nov.	4,250	5,600	3,800	1,300	15,796	15,817	10,857	4,228
Dec.	350	500	1,150	2,600	16,448	16,455	11,120	4,723
Total	65,725	65,725	65,725	65,725	14,065	14,940	14,626	13,223

Summary

FULL	Big Water/Dunes Complex Acreage				Remaining Acreage			
v3.1.0	A/BW	B/BW	C/BW	D/BW	A	B	C	D
Jan.	-	-	-	-	13,025	16,064	11,044	5,869
Feb.	-	-	-	-	12,588	15,593	10,860	6,692
Mar.	-	-	141	-	12,235	15,394	14,918	8,224
Apr.	-	-	1,116	-	12,232	15,193	17,671	10,505
May	-	-	-	395	12,762	13,837	17,189	15,396
Jun.	-	-	-	3,256	13,500	12,550	16,111	17,916
Jul.	-	-	-	430	13,108	10,671	13,530	16,587
Aug.	-	-	-	-	12,683	10,914	9,314	13,129
Sep.	-	-	-	-	12,386	12,678	8,574	8,373
Oct.	-	-	-	-	12,610	14,029	10,137	5,174
Nov.	-	-	-	-	13,043	15,818	10,854	4,228
Dec.	-	-	-	-	13,354	16,455	11,118	4,723
Total					12,794	14,100	12,610	9,735

35,000 Ac								
v3.1.0	Big Water/Dunes Complex Acreage				Remaining Acreage			
	A/BW	B/BW	C/BW	D/BW	A	B	C	D
Jan.	-	-	-	-	10,059	12,244	9,815	5,458
Feb.	-	-	-	-	9,740	11,778	9,542	6,058
Mar.	-	-	-	-	9,497	11,504	11,629	6,753
Apr.	-	-	-	-	9,466	10,944	13,772	8,663
May	-	-	-	-	9,779	10,046	13,039	11,865
Jun.	-	-	-	-	10,257	9,701	12,143	14,410
Jul.	-	-	-	-	9,815	8,451	9,521	13,136
Aug.	-	-	-	-	9,451	8,485	6,898	9,749
Sep.	-	-	-	-	9,350	9,479	6,366	6,531
Oct.	-	-	-	-	9,675	10,565	8,019	4,195
Nov.	-	-	-	-	10,042	11,560	9,629	3,669
Dec.	-	-	-	-	10,278	12,585	9,953	4,562
Total					9,784	10,612	10,027	7,921

SPILL	Big Water/Dunes Complex Acreage				Remaining Acreage			
v3.1.0	A/BW	B/BW	C/BW	D/BW	A	B	C	D
Jan.	-	-	-	-	13,023	16,064	10,992	5,802
Feb.	2,155	4,069	2,205	-	16,613	17,766	16,276	12,361
Mar.	7,371	7,371	7,537	124	17,977	17,983	18,142	17,948
Apr.	6,695	6,695	7,134	1,683	17,860	17,489	18,112	18,084
May	4,934	4,934	5,620	5,828	17,625	16,442	17,630	18,083
Jun.	811	811	1,792	6,990	17,110	14,780	16,541	18,074
Jul.	-	-	-	4,480	15,767	12,001	14,024	16,576
Aug.	-	-	-	-	13,553	10,239	10,033	13,078
Sep.	-	-	-	-	12,001	11,093	8,747	8,309
Oct.	-	-	-	-	11,628	13,570	10,745	5,109
Nov.	-	-	-	-	12,143	15,146	13,043	4,178
Dec.	-	-	-	-	12,742	16,246	13,430	4,863
Total					14,837	14,902	13,976	11,872

Summary

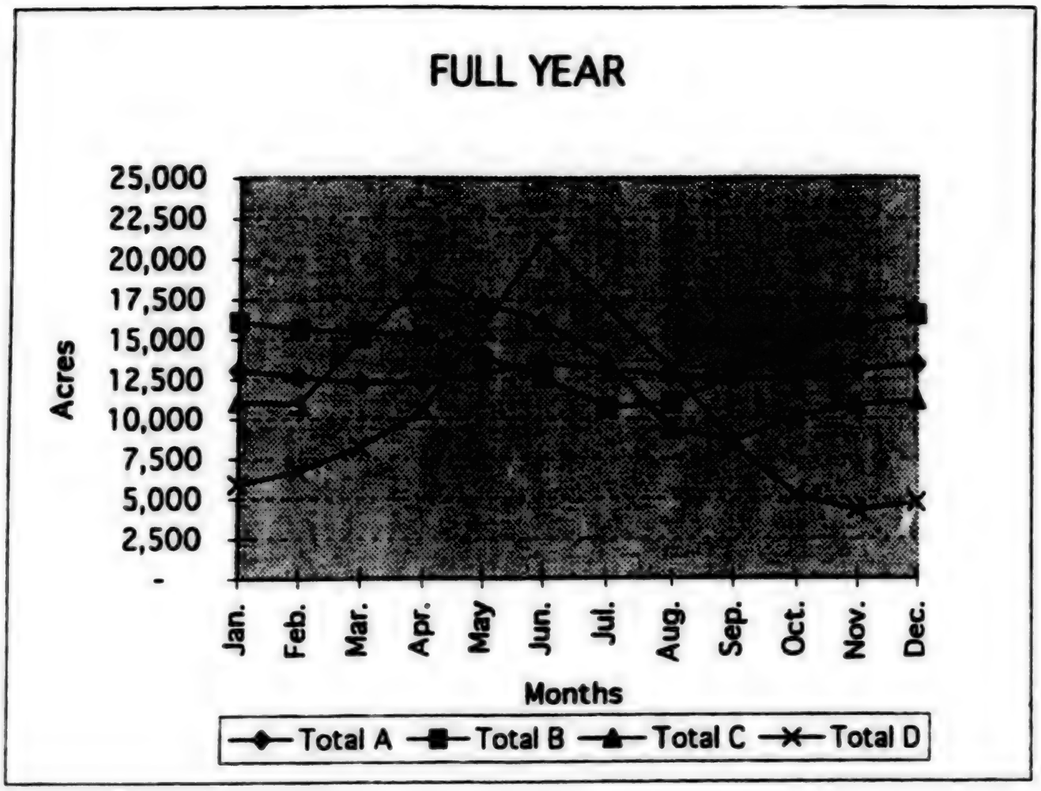
20,000 Ac v3.1.0	Big Water/Dunes Complex Acreage				Remaining Acreage			
	A/BW	B/BW	C/BW	D/BW	A	B	C	D
Jan.	-	-	-	-	7,177	7,764	6,173	3,620
Feb.	-	-	-	-	7,028	7,478	6,018	4,408
Mar.	-	-	-	-	6,920	7,463	7,790	5,084
Apr.	-	-	-	-	6,886	7,414	10,135	5,706
May	-	-	-	-	6,544	6,903	9,247	7,958
Jun.	-	-	-	-	6,775	6,571	7,685	10,055
Jul.	-	-	-	-	6,295	5,600	5,734	8,702
Aug.	-	-	-	-	5,832	5,365	4,390	5,656
Sep.	-	-	-	-	5,844	5,922	4,457	3,465
Oct.	-	-	-	-	6,276	6,954	5,224	2,950
Nov.	-	-	-	-	6,894	7,499	5,912	2,976
Dec.	-	-	-	-	7,189	8,319	6,197	3,285
Total					6,638	6,938	6,580	5,322

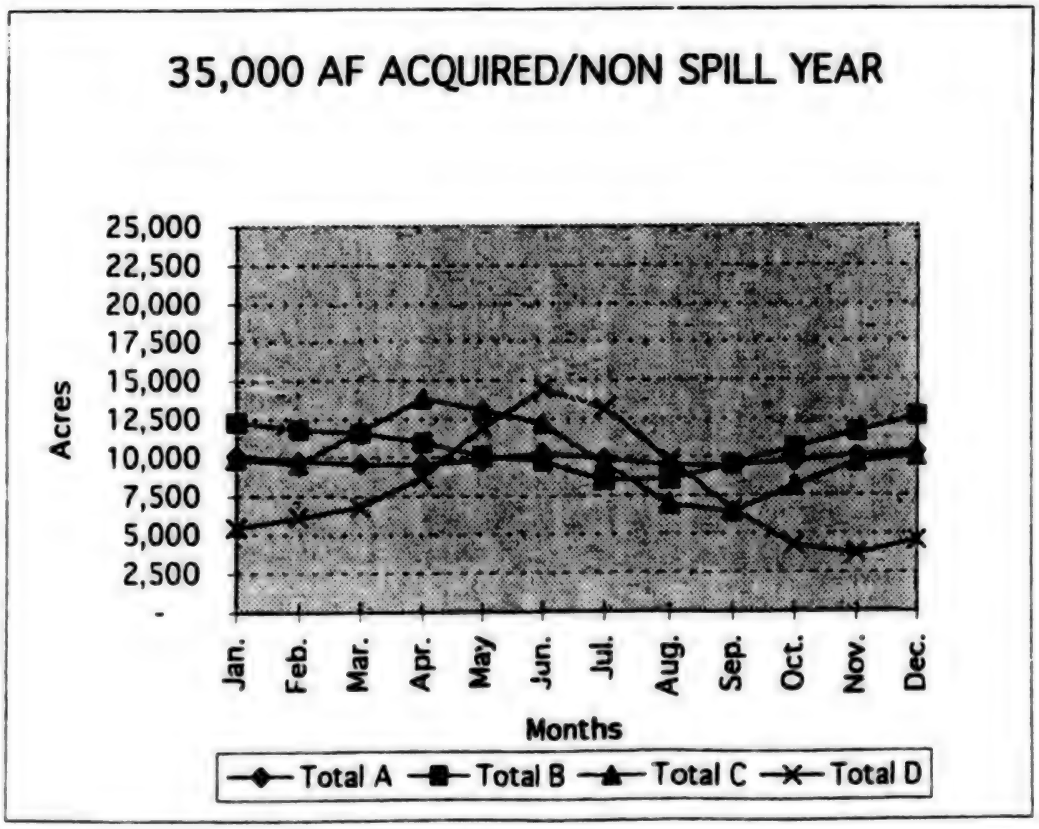
20,000 Ac v.3.1.1	Big Water/Dunes Complex Acreage				Remaining Acreage			
	A/BW	B/BW	C/BW	D/BW	A	B	C	D
Jan.	-	-	-	-	9,581	9,581	9,581	9,894
Feb.	-	-	-	-	8,657	8,657	8,657	9,504
Mar.	-	-	-	-	7,822	8,183	9,495	9,067
Apr.	-	-	-	-	7,279	7,459	10,357	8,489
May	-	-	-	-	5,659	5,440	8,500	8,967
Jun.	-	-	-	-	5,881	5,102	6,917	10,309
Jul.	-	-	-	-	5,612	4,742	5,734	8,954
Aug.	-	-	-	-	5,527	5,018	4,390	6,139
Sep.	-	-	-	-	5,761	5,720	4,457	3,465
Oct.	-	-	-	-	6,172	6,802	5,224	2,950
Nov.	-	-	-	-	6,650	7,327	5,912	2,976
Dec.	-	-	-	-	7,053	7,574	6,197	3,285
Total					6,804	6,800	7,118	7,000

SPILL 96 v.3.1.2	Big Water/Dunes Complex Acreage				Remaining Acreage			
	A/BW	B/BW	C/BW	D/BW	A	B	C	D
Jan.	-	-	-	-	13,023	16,064	10,992	5,869
Feb.	-	-	-	-	12,587	15,593	10,711	6,692
Mar.	1,047	2,741	1,662	-	16,031	17,474	15,896	13,343
Apr.	6,347	7,475	7,420	3,088	18,114	18,114	18,114	18,094
May	5,371	6,488	6,622	5,468	17,897	17,751	17,987	18,083
Jun.	1,393	3,637	3,963	5,492	17,662	17,045	17,657	18,074
Jul.	-	-	-	1,571	17,211	15,473	16,262	16,826
Aug.	-	-	-	-	16,298	13,526	13,842	14,076
Sep.	-	-	-	-	14,598	13,790	12,797	10,467
Oct.	-	-	-	-	14,717	15,562	14,351	8,188
Nov.	-	563	-	-	15,782	17,338	15,408	10,093
Dec.	-	2,495	-	-	16,436	17,631	16,060	11,987
Total					15,863	16,280	15,006	12,649

Summary

FULL FOLL v.3.1.3	Big Water/Dunes Complex Acreage				Remaining Acreage			
	A/BW	B/BW	C/BW	D/BW	A	B	C	D
Jan.	-	689	-	-	16,026	17,266	15,785	13,785
Feb.	-	-	-	-	15,542	16,834	15,395	14,062
Mar.	-	-	2,079	-	15,345	16,670	17,209	14,413
Apr.	-	-	5,275	-	15,122	16,564	18,104	15,974
May	-	-	2,363	3,234	13,756	15,740	17,624	17,731
Jun.	-	-	-	6,033	12,540	14,279	16,583	18,074
Jul.	-	-	-	3,161	10,650	11,350	14,110	16,587
Aug.	-	-	-	-	10,865	10,914	10,133	13,129
Sep.	-	-	-	-	12,667	12,678	8,728	8,373
Oct.	-	-	-	-	14,023	14,029	10,150	5,174
Nov.	-	-	-	-	15,796	15,817	10,857	4,228
Dec.	-	-	-	-	16,448	16,455	11,120	4,723
Total					14,065	14,883	13,816	12,188





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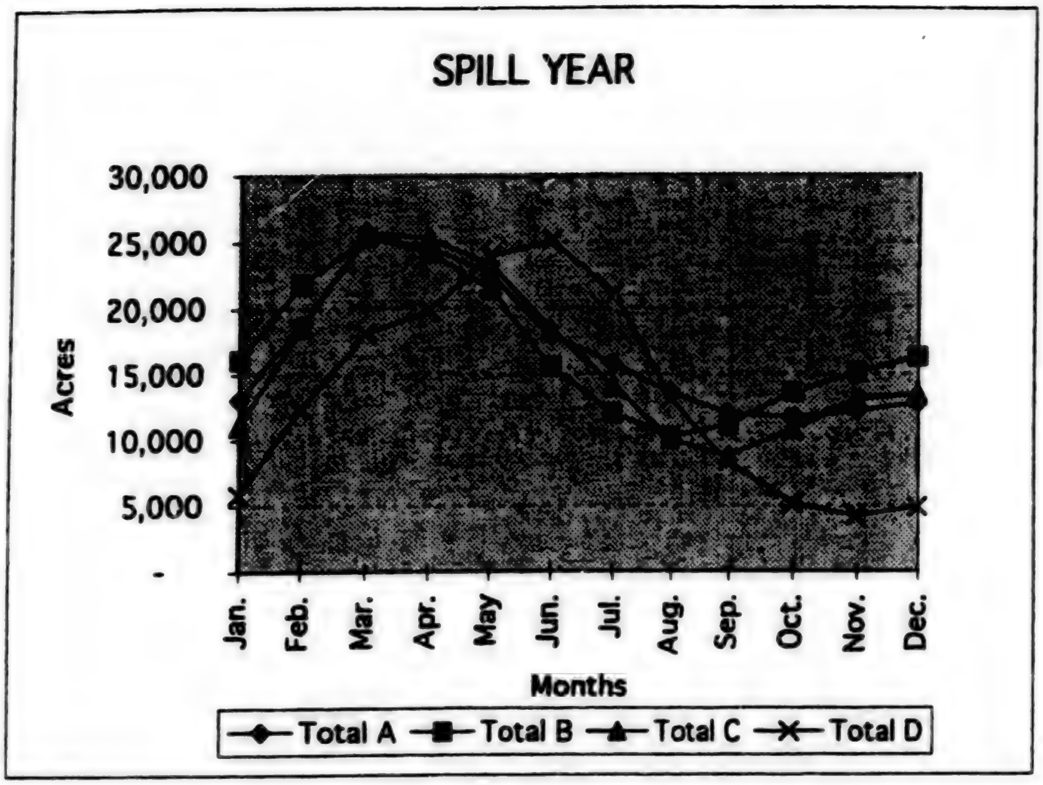
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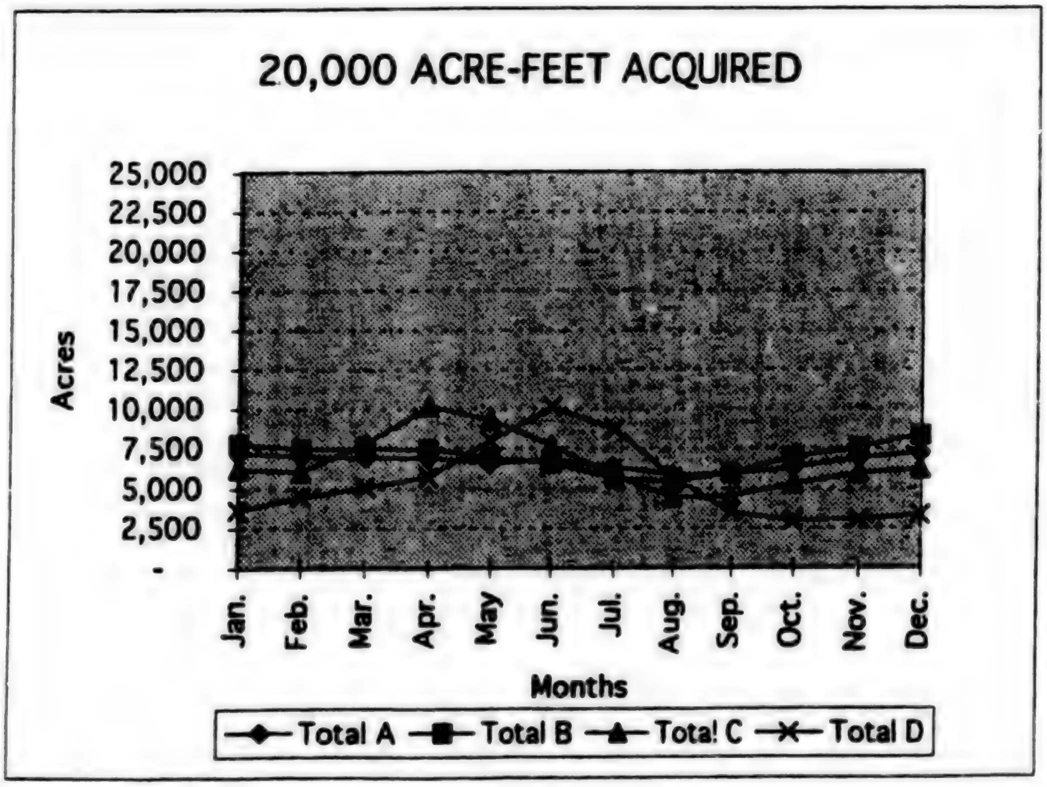
20,000 ACRE-FEET ACQUIRED
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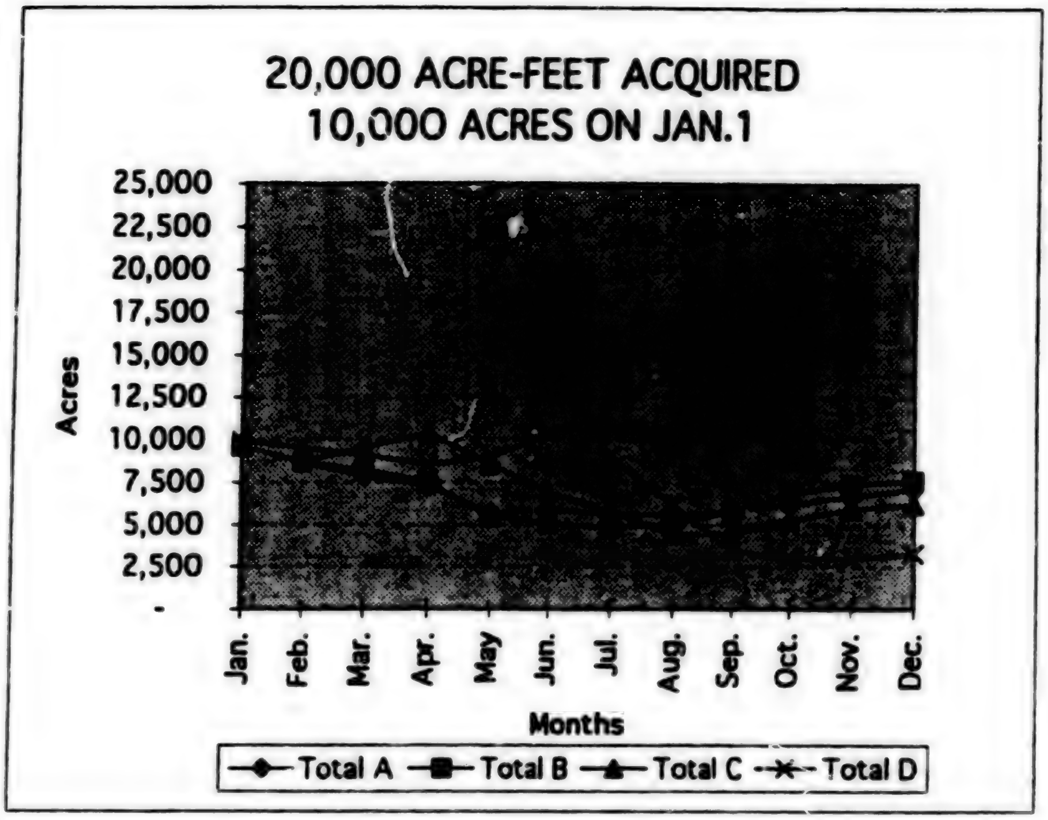

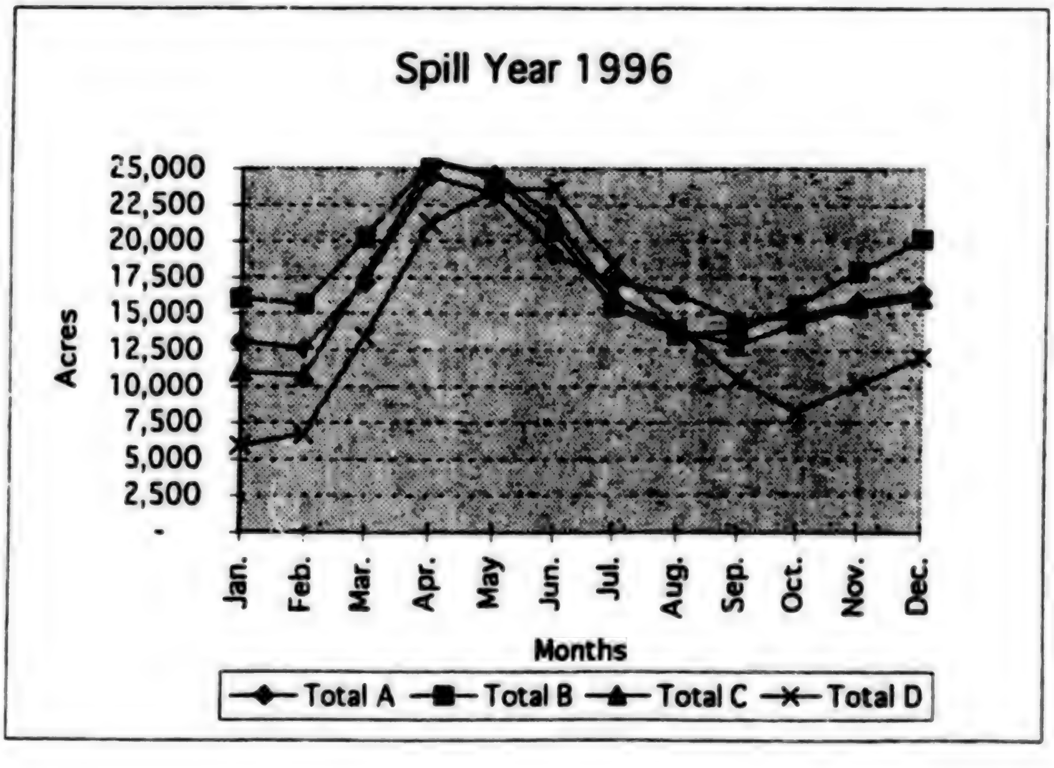

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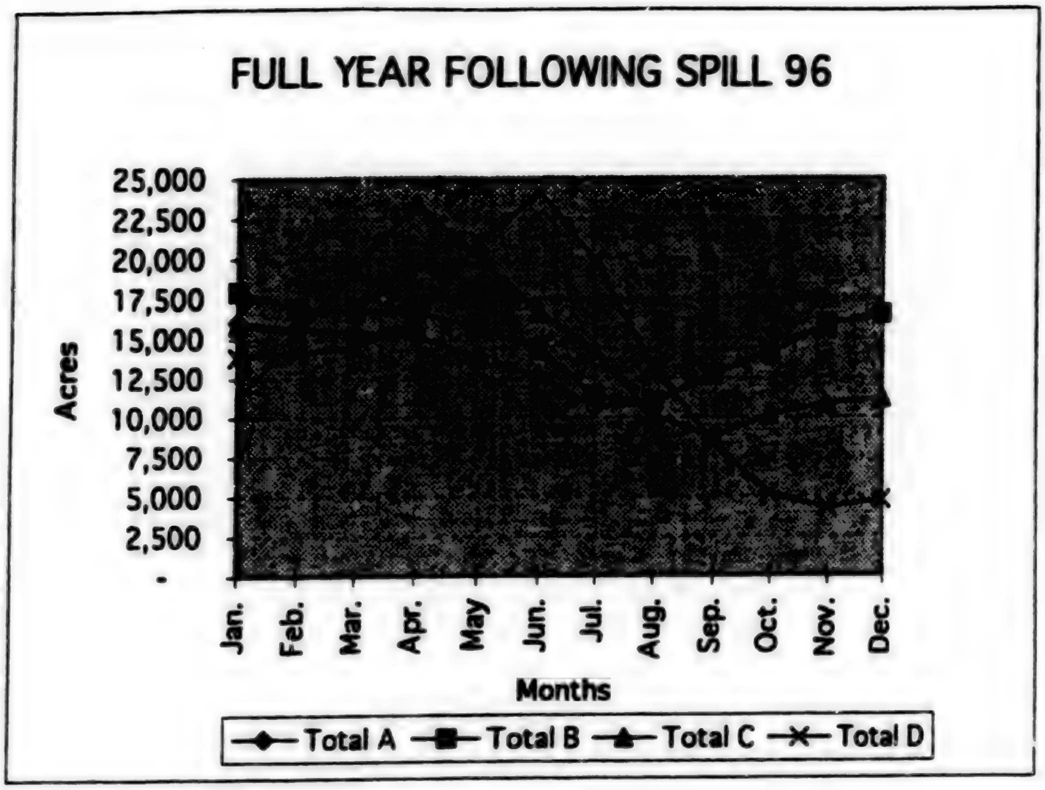

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APPENDIX J:
Draft Saltcedar Integrated Weed Management Plan for Stillwater NWR Complex

Greater Scaup
by Larry Eifert

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Saltcedar Integrated Weed Management Plan
Stillwater National Wildlife Refuge Complex
Fallon, Nevada

Written by: ______________________ Date: ______________
Anita Kang DeLong
Refuge Operations Specialist

Submitted by: ____________________ Date: ______________
Kim Hanson
Refuge Manager

Reviewed: _______________________ Date: ______________
Scott M. Stenquist
Reg. Integ. Pest/Weed Mgmt. Coord.

Approved: ____________________________ Date: ____________
Refuge Supervisor, ARW-CA/NV
Sacramento, CA

____________________________ Date: ____________
Assistant Regional Director,
Refuges and Wildlife
Portland, Oregon

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Saltcedar Integrated Weed Management Plan
for Stillwater NWR Complex

Introduction

Saltcedar (*Tamarix* spp.) is a nonnative plant that was introduced to the United States from Eurasia during the late 1800s (Robinson 1958) and has spread throughout the southwestern United States. Saltcedar established on the Stillwater National Wildlife Refuge (NWR), Stillwater Wildlife Management Area and Fallon NWR, collectively the Stillwater NWR Complex, sometime prior to the 1950s. Flood and drought cycles have increased the distribution and abundance of saltcedar on the refuge complex, in addition to increased saltcedar along the Carson River watershed. Water delivery and storage in wetlands that benefit wildlife also often promotes seed distribution of saltcedar.

The Truckee-Carson-Pyramid Lake Water Rights Settlement Act (Title II of 101-618) directs that Stillwater NWR be managed for the purposes of: (1) maintaining and restoring natural biological diversity within the refuge; (2) providing for the conservation and management of fish and wildlife and their habitats within the refuge; (3) fulfilling the international treaty obligations of the United States with respect to fish and wildlife; and (4) providing opportunities for scientific research, environmental education, and fish and wildlife dependent recreation. P.L. 101-618 also authorizes revision of the Stillwater NWR boundary as may be appropriate to carry out the purposes of the refuge. The National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997, requires that the biological integrity, diversity, and environmental health of the Refuge System be maintained. In addition, Executive Order 12996 (3/25/96) also emphasizes conserving and enhancing the quality and diversity of fish and wildlife habitat within refuges. The Federal Noxious Weed Act of 1975 (P.L. 93-629, 7 USC 280 1 et. seq.) authorizes the Secretary of Interior to cooperate with other Federal agencies, states, territories, districts, political subdivisions, farmer's associations, or similar organizations to eradicate, suppress, control, prevent, or retard the spread of any noxious weed. Although saltcedar is not a federally designated noxious weed, the Noxious Weed Act, amended in 1990, directs Federal agencies to enter into cooperative agreements with states to coordinate management of undesirable species on Federal lands.

Noxious Weed Status

Saltcedar is on the California noxious weed list but is currently not on the Federal noxious weed lists. These lists generally include weed species that are particularly troublesome to agriculture and have some likelihood of integrated weed management. However, it should be noted that the absence of saltcedar on such noxious weed lists does not mean that the plant is unmanageable or not a serious threat to native fish, wildlife, and plant species; livestock grazing; or other agricultural practices. Under the Federal Noxious Weed Act of 1975, the Secretary of Agriculture has the authority to designate plants as noxious weeds and to cooperate with other Federal, state and local agencies, farmer associations, and private individuals to control, eradicate, prevent, or retard the spread of such weeds. A 1990 amendment (Section 1453 under the Food, Agriculture, Conservation and Trade Act of 1990) included integrated management systems to control or contain undesirable plants targeted under cooperative agreements and establish and adequately fund the undesirable management program through the agency's budget process.

Saltcedar's invasive and persistent nature threatens natural biodiversity on Stillwater NWR. Biodiversity is defined as the variety of life and its processes, including the variety of living organisms, the genetic differences among them, and the communities in which they occur (USFWS 1996c). Currently, saltcedar

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Table I. Saltcedar Noxious Weed Status in Nevada, 2/5/98	
Federal (U.S.D.A., Animal Plant Health Inspection Service-Plant Protection and Quarantine [USDA-APHIS-PPQ])	State (Nevada Division of Agriculture)
No	No

has infested refuge wetlands, riparian areas, water delivery system and desert uplands that were previously flooded. Loss of invaluable water through saltcedar transpiration is counter productive to maintaining healthy wetlands for wildlife. Salts accumulate in the soil from saltcedar leaf litter and the excretion of salt from its leaves which prevents the establishment of native plants. In addition, saltcedar slows water flow and increases sedimentation deposition in the refuge water delivery system, causing increased maintenance costs. Saltcedar has significantly altered plant-community structure in many marsh and riparian areas of the refuge complex. For instance, some primarily shallow-emergent marshes with graminoid shorelines are now increasingly monotypic tall-shrub communities of saltcedar. Expansive areas of former meadow communities composed of a diversity of grasses, rushes, and forbs are shifting to monotypic tall-shrub communities.

Saltcedar communities not only out competes native plants; they are less beneficial to wildlife than native plant communities. Angel-Wilson and Ohmart (1978) compared saltcedar communities and cottonwood-willow communities along the lower Rio Grande and found that cottonwood-willow communities supported greater densities of birds and higher bird species diversities than did saltcedar communities. On Stillwater NWR Complex, conversion of native plant communities to saltcedar stands would likewise affect the refuge's diversity of plants and animal species in wetland, playa, riparian and desert shrub upland communities. In addition, saltcedar negatively impacts the refuge's populations of threatened and endangered species which include the bald eagle and western snowy plover as well as species of concern such as the mountain plover, trumpeter swan, white-faced ibis, western least bittern, long-billed curlew, black tern, loggerhead shrike, Nevada viceroy, Great Basin spadefoot toad and northern leopard frog. These species historically occurred on Stillwater NWR Complex but some are now limited in their distribution and abundance.

This saltcedar-management plan addresses the Stillwater NWR goal to restore and maintain natural biodiversity by minimizing the distribution and abundance of saltcedar on the refuge. This plan provides a summary of saltcedar ecology, saltcedar management objectives, integrated weed management strategies, and saltcedar monitoring program for Stillwater NWR Complex.

Ecology of Saltcedar

Saltcedar depends on groundwater for its water supply and can use more than 9 acre-feet of water per acre per year (Robinson 1965). Saltcedar produces large quantities of seed from April to October that are disseminated by wind or water and remain viable for several weeks. The seeds will germinate on saturated soils or while afloat. Slowly receding water levels along river banks or wetland shoreline create optimum seed beds, but survival requires several months without subsequent flooding (Horton et al. 1960).

Once established, saltcedar is difficult to kill. Mature plants are tolerant of heat, cold, drought, flood, and high concentrations of dissolved solids (Everitt 1980). By dropping its leaves and halting growth, saltcedar can withstand lengthy droughts (Horton and Campbell 1974). Mature saltcedar can survive complete submergence for as long as 70 days (Warren and Turner 1975). Under saline conditions, saltcedar absorbs dissolved solids and exudes excess salts through glands in its leaves (Decker 1961). These salts are eventually deposited on the soil surface under the plant, sometimes forming a hard crust (McQueen and Miller 1972). This saline deposit continues to degrade the site and impedes the establishment of other vegetation. Saltcedar grows back vigorously after burning. If saltcedar is cut at or above ground level, the root crown will sprout vigorously. Severed stems and shoots readily root in moist soil and produce new plants. Adventitious roots sprout from submerged or buried saltcedar stems, and buried branches may also reproduce vegetatively (Merkel and Hopkins 1957 as cited by Kerpez and Smith (1987).

Area Description

The project area, which includes Stillwater NWR, Fallon NWR and Stillwater WMA, is approximately 160,000 acres. Currently saltcedar communities have primarily established along water delivery canals, the periphery of wetlands, and the Carson River and delta. The saltcedar acreage is continually expanding. The January 1996 National Weed Survey reported an estimated 1,000 acres of saltcedar on Stillwater NWR and 45 acres on Fallon NWR (Table II, page 15). During 1997, a ground survey of saltcedar was conducted at Stillwater NWR, Stillwater WMA and Fallon NWR to obtain a more accurate inventory of saltcedar on Stillwater NWR Complex. Although the survey was completed, the maps have yet to be made available in digital format and, therefore, saltcedar acreages are pending.

Saltcedar communities within the project area range from expansive, dense stands to isolated patches and single trees. Plant height ranges from seedlings only inches tall to trees of 25 feet. Average plant height for the majority of saltcedar on the project area is 7 feet.

Historical records document presence of saltcedar as early as 1950 (USFWS 1950). In 1950, USFWS reported that, "It has only been quite recently that we have recognized the full extent of tamarisk growth in the marsh area. Most of this growth is new, consisting of seedlings established in the past two years, and it does not show up except on close inspection of the marsh edges... The biggest problem area is Stillwater Point Reservoir and the channels distributing the Reservoir water... Tamarisk is widely distributed throughout the other parts of the marsh, but usually occurs only as individual, or small groups of plants. There is, though, a considerable growth in the Indian Lakes area particularly about one of the ponds receiving water from the Shoffner Drain." The report also mentioned 5 ½ acres between Foxtail Canal and the East Canal that contained saltcedar plants of various sizes from seedlings to bushes 6 to 9 feet tall.

The sporadic and relatively limited efforts to control saltcedar that have occurred over the last five decades have had little effect in curbing the spread of this species. In 1950, 2,4-D was sprayed to control saltcedar (USFWS 1950). Floods in the mid-1970s, 1980s, and again in late 1990s increased saltcedar distribution and abundance throughout the project area. Water management at Stillwater NWR that is beneficial to shorebirds, spring fill-up and receding water levels by late-summer, also allows for optimum saltcedar establishment.

Goal and Objectives

Although eradicating saltcedar from the project area is unrealistic at this time, a well designed and implemented saltcedar integrated weed management plan could effectively control this species within tolerable limits. Control methods that achieve an 80 to 90 percent kill of saltcedar plants will be considered successful based on criteria established for Kern and Pixley NWRs (USFWS 1996a) and results reported in Kerpez and Smith (1987). Follow-up control will be a necessary part of the management plan.

Goal:

Halt the expansion of saltcedar and reduce saltcedar to less than 15 percent of the vegetation cover within plant communities that contain saltcedar on Stillwater NWR, Fallon NWR, and Stillwater WMA .

Objectives:

1. Conduct a baseline inventory of saltcedar. Document the distribution, abundance, and size of saltcedar on the area and use the baseline saltcedar inventory as a standard from which to evaluate subsequent inventories. Saltcedar inventories will be repeated at a maximum of every 5 years.

2. Use mechanical, chemical, and/or inundation control methods to treat all of the priority areas within the next 15 years. Priority areas are areas on the refuge that have low densities of saltcedar stands, small/isolated patches of saltcedar and/or outlier saltcedar plants. The priority areas are generally located in the northern portion of the refuge (i.e., North Nutgrass, Nutgrass Road, north of North Road, Map 1) and are targeted to prevent the spread of saltcedar into pristine areas. Moderate density stands (Upper and Lower Foxtail, Dry Lake, Doghead, Cattail, Goose, East Alkali, South Nutgrass, West Nutgrass, Swan Check, Swan Lake) will be treated as time allows.

3. Continue to promote Stillwater NWR Complex as a release site of biological control insects, the leaf beetle (*Diorhabda elongata*), and strive to release the leaf beetles on the refuge within 5 years. Release of the leaf beetles will occur on sites that contain high density saltcedar stands (i.e., Lead Lake, North Tule, Stillwater Point Reservoir, D Line from North Paiute to Van Slough, Map 1).

4. Develop a monitoring program to track and evaluate the saltcedar control efforts on Stillwater NWR Complex. Adopt standardized saltcedar monitoring protocols and procedures developed by the US Fish and Wildlife Service Regional Office, USDA- Agricultural Research Service, and USDA-Animal Plant Health Inspection Service. Monitoring must occur to document pre- and post-effects of pest management (biological, chemical, mechanical, and inundation methods). Treatment data (i.e. treatment method, location, date, acreage, site characteristics) should be documented in a geographic information system (GIS) data base.

5. Develop on-the-ground vegetation restoration efforts to replace saltcedar with native, site-specific grasses, forbs, shrubs, and trees.

Integrated Weed Management Strategies

Integrated Weed Management (IWM) involves the use of several control techniques in a well-planned, coordinated, and organized program to reduce the distribution and abundance of saltcedar within the project area. Inventory and mapping is the first phase of this IWM program. The second phase includes prioritizing the management of weed problems, and choosing and implementing control techniques strategically (inundation, biological, chemical, and mechanical controls). The third phase is restoration of treatment sites with native vegetation and the forth phase is the continued yearly treatment of saltcedar. Phases pertain to particular treatment sites, not the IWM program as a whole (e.g., while one site is in phase four, another site may be in phase two). Periodic monitoring using documented, replicable methods is critical to ascertain success/failure and to modify methods accordingly. The IWM program is a step-down management plan of the comprehensive conservation plan for Stillwater NWR Complex.

Inventory and Monitoring

The Service needs to be able to demonstrate and articulate failure and success of the integrated weed management plan. Survey methods need to be standardized and repeatable. The Service will explore cooperative efforts with U.S. Department of Agriculture (USDA)-Agricultural Research Service, USDA-Natural Resources Conservation Service and other entities to obtain aerial photographs of Stillwater NWR Complex. Saltcedar inventories will be repeated at a maximum of every 5 years and digitized into GIS - Arc Info.

A baseline inventory was conducted from February 25 to December 16, 1997 (Appendix A: 1997 Saltcedar Survey Notes). Saltcedar distribution was mapped on topographic maps by ground surveys. Saltcedar communities were characterized by describing dominant tree height and estimated age-class (seedling, sapling, young trees, and mature trees). Maps will be digitized and will serve as baseline data to compare to subsequent surveys. Periodic inventories will be conducted within 5-year intervals to assess changes in saltcedar distribution and abundance and assess results of the saltcedar management plan.

All treatment sites must be closely monitored to determine success of control methods. At a minimum, photo sites will be established and pre- and post-treatment photos taken at treatment sites. Documentation of treatment dates, area, control methods, post-control treatment methods, photo documentation and results must be maintained and stored in refuge files. Photo sites should be documented in this section on an attached map with a description on each photo of location and Universal Transverse Mercator (UTM) coordinates. Permanent photo sites should be marked on location with a rebar and metal tag with UTM coordinates. Photos should include a data reference point, photo taken toward some definite landmark that is not likely to change or move. The photo survey should be completed annually and maintained in a permanent refuge file.

Everitt et al. (1995) recommends the use of airborne video data with global positioning system technology for mapping and monitoring saltcedar. Everitt et al. described how Chinese tamarisk (*Tamarix chinensis*) could be distinguished from other plant species along riparian corridors in Arizona and Texas in late November when its foliage turned yellow-orange to orange-brown prior to leaf drop. This and other techniques for mapping saltcedar on the refuge are being investigated. Another option for mapping/monitoring saltcedar is obtaining satellite digital photos from Landsat which has a 30 meter pixel resolution. The cost was reasonable for images 1 year or older; however, the resolution (30 meter pixel) was considered too large to capture saltcedar along water delivery canals and in areas of sparse saltcedar stands.

Control Methods

Mechanical Control Methods

Root plowing can be effective if the root crown of saltcedar plant is removed. The root plow must be at least 18 inches below the ground (Kerpez and Smith 1987) in order for the root crown to be severed. If the root crown is removed, lower roots will not sprout and form new plants (Horton 1960). The above-ground vegetation can be removed before or during root plowing, and should be piled and burned to prevent resprouting of shoots and stems. Root plowing during hot and dry weather (which promotes rapid drying of severed stems and shoots) will help prevent resprouting of unburned stems or shoots. Long, straight, and overlapping swaths should be root plowed to avoid missing plants (Kerpez and Smith 1987). Horton

(1960) reported that root plowing killed more than 90 percent of saltcedar present. Kerpez and Smith (1987) considered this technique the most effective method available.

Prior to any mechanical control of saltcedar, a cultural resource survey would be completed for the proposed treatment area. Because cultural resources are prevalent within the project area, mechanical control methods may often be an inappropriate control method.

The following mechanical methods and procedures were developed and implemented at Bosque del Apache NWR and Kern NWR (USFWS 1996a) and should be considered for use at the Stillwater NWR Complex.

Medium - Large Dense Stands of Saltcedar on Flat Terrain

M1. Traced-dozer with blade attached, pulling wheel type high arch root rake. Equipment will knock down standing trees, rake and windrow trunks and limbs. Crisscrossing the area once is necessary before root plowing. Attached dozer blade will protect radiator from tree limbs.

M2. Tracked-dozer with blade attached, pulling a root plow equipped with hydraulic rear arch attachment, to shear stumps below bud zone 18 to 24 inches deep and loosen soil for root raking. Attached dozer blade will help smooth surface and help protect radiator.

M3. Repeat procedure M1 without crisscrossing the area root plowed, and windrow the woody debris.

M4. Articulating 4WD wheel loader. Front bucket is replaced with heavy duty multi-application rake. This equipment consolidates windrowed woody debris into large piles relatively dirt free. Piles are left to dry two years to ensure a complete burn to ashes of all woody material.

Isolated Stands or Single Trees

M5. Articulating 4WD wheel loader. Loader arms are mounted with a single tree gruber-stinger. This equipment is used in areas not possible or practical for root plowing and raking, and where trees are at the toe or on slopes of dikes.

M6. Repeat procedure M4 under control of large dense areas to consolidate debris for burning. Multi-application rake is used to rake roots and buds from the ground.

Chemical Control Methods

Herbicides can be applied on the foliage, to the base of the plant, to the stump of cut plants, or to the root zone (Hollingsworth et al. 1973 and 1979). Application of herbicides to cut stumps kills more saltcedar than basal applications to live stems (Hughes 1965). Application of herbicides should occur when saltcedar is in full bloom or when leaves are in the growth stage (USFWS 1996b). There currently are three methods for applying herbicides on refuges to control saltcedar. Table III (page 17) summarizes these strategies (USFWS 1996b).

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C1. Aerially (helicopter) spray a mixture of 2 pints Arsenal, 6 pints Rodeo, 1 pint nontoxic surfactant, and 8.8 gallons of water per acre. This is referred to as a 10 gallon per acre mix. This method has been used at Bosque del Apache NWR, Ash Meadows NWR and numerous irrigation/water districts in the southwest. Saltcedar plants may take up to several years to die after treatment. Once dead, trees should be cut or knocked down with a dozer, stacked and then burned.

Advantages of Rodeo-Arsenal Mix are: (1) Arsenal enhances the ability of Rodeo to penetrate the physical structure of the leaf which increases the translocation of the Rodeo throughout the plant; (2) each product attacks three different amino acids of the plant, resulting in increased effectiveness; and (3) by cutting Arsenal with Rodeo, a significant cost reduction can be achieved without loss of effectiveness (USFWS 1994).

To date, Arsenal has not be registered for use over water, although certification is pending. Therefore, aerial application on Stillwater NWR would not be feasible unless the site is dry. Arsenal is registered in California and Nevada. Pending registration, an application for use can be submitted the State Department of Pesticide Regulation under their Research Investigation Authorization Procedures under Section 5, Experimental Use Permits, Federal Insecticide, Fungicide, and Rodenticide Act.

C2. Spraying with high-volume, hand held, pressurized vehicle mounted equipment. The herbicide would be the same chemical mixture used in aerial application. For the herbicide to kill a tree, the entire foliage must be sprayed. This method could be used to treat single or isolated stands of trees. Again, once treated it could take several years for all the trees to die. Again, trees may need to be downed, stacked and burned.

C3. Spraying with low-volume, hand held equipment. The herbicide used is 1 quart of Garlon 4 per 1 gallon of water. This herbicide would be applied to the remaining stumps following cutting with a chainsaw or rotary brush cutter. Leave a 12 to 18 inches stump above ground to allow for a wheel loader with clam shell to pull up individual trees. The herbicide mixture must be applied immediately (within seconds of cutting). Kern and Pixley NWRs (USFWS 1996a) reported 80 to 85 percent kill mortality with no regrowth. This method requires large amounts of man-hours and therefore impractical for large areas of saltcedar unless volunteer labor, youth employment groups, or prison work parties are available. In any case, state pesticide certification and licensing are required for employees using pesticides.

Inundation

Long-term submergence will kill saltcedar (Kerpez and Smith 1987). Kerpez and Smith (1987) recommend removing above-ground portion of saltcedar before inundating. If plants are not removed, completely submerge them for at least 70 days (Warren and Turner 1975). Inundation has been effective at Stillwater NWR against saltcedar seedlings less than 10 inches tall or young plants that are mowed prior to inundation. Seedlings will be killed within a couple of weeks if completely submerged (Henry 1998).

Biological Control Insects

Currently, the biological control insect that appears the most promising is the leaf beetle (*Diorhabda elongata*) which is native to the People's Republic of China and is cold tolerant. Biological control investigative and operational work is being done by USDA - Agricultural Research Service (Dr. Jack DeLoach, Principal Research Scientist) and USDA-Animal Plant Health Inspection Service (Richard Gaspari and Juli Gould) for Saltcedar Biological Control .

A draft biological assessment was completed (DeLoach and Tracy 1997) and the information was used in an environmental assessment, in compliance with National Environmental Policy Act, for the proposed controlled release of the leaf beetle to test sites in Nevada, California, New Mexico, Texas, Arizona, Wyoming, and Colorado. The U.S. Fish and Wildlife Service offices in Las Vegas, Nevada, Carlsbad, California, Grand Junction, Colorado, and Cheyenne, Wyoming reviewed the draft biological assessment and prepared their biological opinion on possible impacts on the Federal endangered southwestern willow flycatcher *(Empidonax traillii extermus)* under the Federal Endangered Species Act. The U.S. Dept. Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (USDA-APHIS-PPQ) draft environmental assessment on the saltcedar leaf beetle was available for public comment from March 18 to June 4, 1999. The environmental assessment and Finding of No Significant Impact were issued after the public comment period closed.

The USDA-APHIS-PPQ began to issue permits (USDA-APHIS-PPQ Form 526, Permit to Move Nongenetically Engineered Live Plant Pests or Noxious Weeds) for the release of the saltcedar leaf beetle, *Diorhabda elongata*, into field cages on July 8, 1999 at a total of ten sites in six states, including the Lovelock, Nevada area (Stillwater NWR, the Fallon Paiute-Shoshone Indian Reservation and the Walker River Paiute Indian Reservation). The release of the saltcedar leaf beetle onto Stillwater NWR Complex is subject to the approved environmental assessment and Finding of No Significant Impact to be completed by the Service. Stillwater NWR staff are currently working on the environmental assessment.

Annual monitoring of saltcedar abundance and density, along with other invasive species, is important at Stillwater NWR Complex. Monitoring of the saltcedar leaf beetle is also extremely critical to the station's saltcedar management effort. Monitoring was required by the Service in its revised condition of approval, dated June 15, 1999, under authority of the Federal Endangered Species Act in comments to USDA-APHIS-PPQ for release of the saltcedar leaf beetle into cages.

Fire

Burning can be beneficial in saltcedar management if performed at the proper time with post-fire herbicide or other treatment of saltcedar resprouts (Jorgensen, 1996). Fire can be used to reduce saltcedar depending on the timing of the burn; fire-behavior, -intensity, and -management, and follow-up efforts. While fire destroys above-ground plant matter, saltcedar vigorously resprouts making herbicide treatment an important component of post-wildfires or -prescribed burns. Saltcedar will invade after a burn, so follow-up herbicide treatment along with re-establishment of native vegetation is essential. Optimum conditions for prescribed burning of saltcedar seem to be during the summer and fall, and include stand maturity greater than 4 years old, low dead-fuel moisture, and abundant litter in the summer or fall (Bureau of Reclamation 1995). A Fire Management Plan (Appendix K: Draft Fire Management Plan) for Stillwater NWR Complex will be developed for prescribe burning and suppressing wild fires.

Wild fires may provide the opportunity to rehabilitate saltcedar stands where conditions for prescribed fire seldom occur because of smoke management, crew and equipment availability, landowner or agency agreement, or other constraints. A "wildfire rehabilitation plan" will be written and approved in order for national wildfire funding to be used to restore the site to pre-wildfire conditions. As with prescribed burns, the objective of using wildfires is to cause minimum disturbance to the site's native soil, water, and other characteristics while removing the saltcedar vegetation. Site monitoring, revegetation with native species, and post-treatment of regrowth of saltcedar and other noxious weeds is essential. Otherwise, saltcedar and other noxious weeds will reinvade the burned site.

Reestablishing Native Vegetation Communities

Comprehensive saltcedar management requires initial treatment, post-control treatment of saltcedar resprouts and seedlings, project monitoring, and the reestablishment of native vegetation. During this integrated weed management process, it is important to treat existing and invading exotic herbaceous annuals and perennials, in addition to saltcedar, while minimizing impacts to native vegetation (non-target species). The loss of mycorrhizal fungi and the other beneficial soil organisms favors exotic, nonnative species (St. John 1996). St. John (1996) noted that mycorrhizal fungi can be applied through the addition of top soil to a site or by subsurface incorporation/injection of commercial mycorrhizal inoculum.

Passive restoration is the preferred method of reestablishing cattail and bulrush in wetland units. However, desert upland sites and riparian sites may require active revegetation efforts. Desert upland sites may require plantings of desert shrubs such as greasewood, shadscale, spiny hopsage and rabbitbrush, depending on site potential, if native recolonization is unexpected or slow. Riparian sites along the Carson River and Stillwater Slough may require plantings of cottonwood, willow, wild rose, buffaloberry and other native shrub species.

Planting techniques used for revegetating farmland, acquired through the Water-Rights Acquisition Program, with native vegetation will be applied to reestablishing native vegetation communities after saltcedar treatment. Two techniques have been used successfully to date to revegetate abandoned farmland: shrubs planted in containers and seeds drilled into the ground. In the shrub planting technique, seeds were collected at Stillwater NWR from greasewood, rabbitbrush and saltbush and grown in containers by the Nevada Division of Forestry nursery. Future plantings should also include other native species such as shadscale, and spiny hopsage. Planting sites were pre-irrigated and irrigated once after planting. Plantings at the DeBraga tract occurred in June and July, 1992 by hand planting, but future plantings should be conducted in the fall when more moisture is available to plants. Cost was approximately $54 per acre. For the seed drilling technique, a native grass/shrub seed mixture at 5 to 6 pounds per acre was drilled in the fall and flood irrigated once after planting and once in the spring (McDonald tract). Seed mixture contained alkali sacaton, Great Basin wildrye, western wheatgrass, four-wing saltbush, quailbush, and gooseberry leaf globemallow. Cost for the planting was approximately $40/acre.

Partnerships and Funding Needs

Saltcedar is not limited to the boundaries of the Stillwater NWR, Fallon NWR and Stillwater WMA; it is a problem species that has invaded the Lahontan Valley. Efforts to control saltcedar on the refuge will be unsuccessful in the long run if the problem is not addressed in a valley wide effort. Saltcedar seeds are transported, in part, via the Carson River and the irrigation water delivery system. Establishment of saltcedar in pastures reduces the livestock grazing potential of these areas. Saltcedar in the irrigation delivery system hinders the movement of water and allows for sedimentation deposition, increasing operational costs. Saltcedar establishment in the Carson River not only increases the potential for flooding but also out-competes the native cottonwood community and negatively impacts dependent wildlife. Saltcedar's voracious consumption of groundwater in this desert climate negatively effects all residents of Lahontan Valley.

Control of saltcedar and restoration back to native grasses, shrubs, and trees require people, equipment, and materials. In 1996, Bosque del Apache estimated the costs of mechanical saltcedar control at $521 per acre and estimated costs for Stillwater NWR are expected to be similar.

Table IV. Grants applied for by Stillwater NWR Complex to control saltcedar on the refuge.

Grant Organization	Project Title	Date	Funding Requested	Proposed Partnership Matching Contribution	Status	Project Description
National Fish and Wildlife Foundation	Saltcedar Control Project	11/97	$20,000	$31,000	denied	Restore native wetland habitat by controlling saltcedar using mechanical and chemical methods. (100 acres)
National Fish and Wildlife Foundation	Sensitive Plant Survey &Vegetation Inventory	1/97	$10,000	$12,860	denied	Conduct a sensitive plant survey and inventory upland and exotic plant communities. (160,000 acres surveyed)

List of Potential Cooperative Partners

Churchill County
Churchill County Mosquito Abatement District
Ducks Unlimited
Fallon Paiute-Shoshone Tribe
Lahontan Conservation District
Natural Resource Conservation Service
Naval Air Station - Fallon
Nevada Division of Agriculture
Nevada Division of Wildlife
Nevada Native Plant Society
Nevada Natural Heritage
Private Landowners
Sierra Club
Stillwater Conservation District
The Nature Conservancy

U.S. Department of Agriculture
    Agricultural Research Service
    Animal Plant Health Inspection Service, Plant Protection and Quarantine
    Natural Resource Conservation Service
U.S. Department of Interior
    Bureau of Indian Affairs
    Bureau of Land Management
    Bureau of Reclamation
    Fish and Wildlife Service
    Geological Survey, Biological Resources Division
    National Park Service
University of Nevada, Reno

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Table II. Summary of Saltcedar Problems on U.S. Fish and Wildlife Service Lands Weed Survey, January 1996.

State	National Wildlife Refuge (including coordination and wildlife mgmt. areas)	Saltcedar Spp. *Tamarix*	Acres Affected
ARIZONA			
	Bill Williams	*chinensis*	1,900
	Gilla River Waterfowl Management Area	*chinensis*	4,830
	Kofa	*ramosissima*	5
	San Bernardino	*chinensis*	1
ARIZONA, CALIFORNIA (Colorado River)			
	Cibola	*chinensis*	10,000
	Havasu	*chinensis*	6,000
	Imperial	*chinensis*	7,000
CALIFORNIA			
	Bitter Creek	*ramosissima*	200
	Coachella Valley	*chinensis*	10
	Kern	spp.	3,080
	Pixley	spp.	10
	Sacramento River	*ramosissima*	50
	Salton Sea	*chinensis*	500
	Sweetwater Marsh	spp.	2
	Tijuana Slough	spp.	270
COLORADO			
	Browns Park	spp.	75
MONTANA			
	Charles M. Russell	*ramosissima*	100
NEBRASKA			
	North Platte	*ramosissima*	1
NEW MEXICO			
	Bitter Lake	*ramosissima*	5,000
	Bosque del Apache	*chinensis*	4,000
	Dexter National Fish Hatchery	*chinensis*	150
	San Andres	*chinensis*	16
	Sevilleta	*chinensis*	8,600

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Table II. Summary of Saltcedar Problems on U.S. Fish and Wildlife Service Lands Weed Survey, January 1996.

State	National Wildlife Refuge (including coordination and wildlife mgmt. areas)	Saltcedar Spp. *Tamarix*	Acres Affected
NEVADA			
	Amargosa Pupfish Research Station	*ramosissima*	1
	Ash Meadows	*aphylla*	30
	Ash Meadows	*ramosissima*	400
	Fallon	*ramosissima*	45
	Marble Bluff Fish Research and Control Station	*ramosissima*	1
	Moapa Valley	*ramosissima*	5
	Pahranagat	*ramosissima*	200
	Stillwater	*ramosissima*	1,000
OKLAHOMA			
	Salt Plains	*gallica*	4,000
TEXAS			
	McFaddin	*chinensis*	1
UTAH			
	Bear River Migratory Bird Refuge	*ramosissima*	10
	Fish Springs	spp.	777
	Ouray	*ramosissima*	1,340
WASHINGTON			
	Saddle Mountain	*ramosissima*	1
WYOMING			
	Seedskadee	spp.	5

	Sub-total	*T. aphylla*	30
	Sub-total	*T. chinensis*	43,008
	Sub-total	*T. gallica*	4,000
	Sub-total	*T. ramosissima*	8,359
	Sub-total	*T.* spp.	4,219
	Total		59,616

Saltcedar summary table on FWS lands, 1/96-Weed Survey, All Regions, Regions 1, 2, 6

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Table III. Herbicides Labeled for Saltcedar (USFWS 1996b).[1 2 3]

Herbicide (Trade Name)	Herbicide (Chemical Name)	Manufacturer	Application				Comment
			Foliar	Cut Stump	Basal Bark	Aerial	
Arsenal®	Imazapyr	American Cyanamide	✓	✓		✓	Used in combination with Roundup Pro or Rodeo, these two herbicides develop a synergistic relationship. Arsenal/Rodeo combination not labeled for use in California effective October 15, 1996. Rodeo has aquatic label registration. Arsenal has residual soil activity, but no aquatic label registration.
Garlon® 3A	Triclopyr	DowElanco	✓	✓	✓		Non-volatile amine-salt formulation and should be applied during the growing season. Safe for many grass species. No residual soil activity. During the application of herbicides on the cut stump, it may be helpful to apply a color marking material so that treated versus untreated stumps are obvious. One such material is Becker-Underwood's "Hi-Light Dye Tab" (Becker Underwood Inc., 801 Dayton Ave., Ames, IA 50010 (515-232-5907, FAX 5515-232-5961). Contact Becker Underwood to determine their recommendations for each herbicide and their dye product.
Garlon® 4	Triclopyr	DowElanco	✓	✓	✓		Low-volatile ester formulation. Safe for many grass species. No residual soil activity. Can be used in the "dormant" season as a basal application.
Pathfinder® II	Triclopyr	DowElanco		✓	✓		Oil soluble formulation. Safe for many grass species. No residual soil activity. Can be used in the "dormant" season as a basal application.
Rodeo®	Glyphosate	Monsanto	✓	✓		✓	Aquatic registration.
Roundup® Pro	Glyphosate	Monsanto	✓	✓		✓	No residual soil activity.

From: U.S. Fish and Wildlife Service. 1996b. Draft, Saltcedar Management Strategy. ARW-OPR, Portland, OR. 23 pp.

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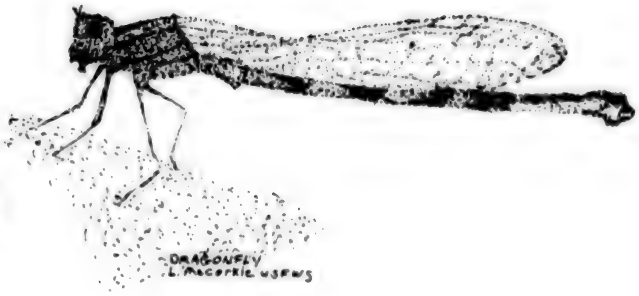
APPENDIX K:

Draft Fire Management Plan (Selected Components)



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DRAFT 3/24/99

FIRE MANAGEMENT PLAN

STILLWATER NATIONAL WILDLIFE REFUGE COMPLEX

CHURCHILL COUNTY, NEVADA

Prepared by: Dan Dearborn Date: 3/24/99
Fire Management Officer

Prepared by: Andy Goheen Date: 3/24/99
Prescribed Fire Specialist

Submitted by: ______________________________
Project Leader (name/signature/date)

Reviewed by: ______________________________
Fire Management Officer (name/signature/date)

Reviewed by: ______________________________
Regional Fire Management Coordinator (name/signature/date)

Approved by: ______________________________
Regional Director, Region 1 (name/signature/date)

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FIRE MANAGEMENT PLAN

STILLWATER NATIONAL WILDLIFE REFUGE COMPLEX

I. INTRODUCTION

This plan was written to help achieve resource management objectives outlined in the Draft Comprehensive Conservation Plan (CCP) for Stillwater National Wildlife Refuge (NWR) Complex.

Management today is concerned about maintaining quality habitat for all migratory and native species which may frequent the Refuge, providing compatible and wildlife dependent public-use opportunities, understanding and protecting cultural resources, and providing interpretative and educational information on the Refuge's habitat, wildlife, and cultural resources. The purpose of this plan is to help achieve these objectives.

Fires occurring under certain climatic conditions and season have adverse effects on Refuge habitats. The Project Leader at Stillwater NWR Complex will meet with local fire department officials to develop agreements to provide fire protection for U. S. Fish and Wildlife Service (Service) lands. The agreement(s) will be incorporated into this plan.

II. DESCRIPTION OF REFUGE

Please refer to Chapters 2 and 4 of the Draft Environmental Impact Statement (Draft EIS) (this information will be contained in the final Fire Management Plan).

III. COMPLIANCE WITH U.S. FISH AND WILDLIFE SERVICE POLICY

A. Compliance With Service Policy

U.S. Fish and Wildlife Service Departmental Manual 620 DM 1 requires all refuges supporting vegetation capable of sustaining fire to complete a Fire Management Plan. This plan provides fire management guidelines for Stillwater NWR Complex.

B. NEPA Compliance and Authorities Citations

This plan meets the requirements of the National Environmental Protection Act (NEPA). An Environmental Assessment will not be completed for prescribed fire due to new regulations published in the Federal Register (62 FR 2375) January 16, 1997. The new regulation categorically excludes prescribed fire when used for habitat improvement purposes and conducted in accordance with State and local ordinances and laws. Wildfire suppression and prescribed fire are both categorically excluded, as outlined in 516 DM 2 Appendix 1. The Service has involved the public through preparation of a Draft CCP for Stillwater NWR Complex.

The statutes cited herein authorize and provide the means for prevention, preparedness, control, and suppression of wildfire on lands under the jurisdiction of the Department of the Interior, or lands adjacent thereto.

1. Reciprocal Fire Protection Act of May 27, 1955 (69 Stat. 66; 42 U.S.C. 1856 a) authorizes reciprocal fire protection agreements with any fire organization for mutual aid with or without reimbursement and allows for emergency assistance in the vicinity of agency facilities in extinguishing fires when no agreement exists.

2. National Wildlife Refuge System Administration Act of 1966 as amended (80 Stat. 927; 16 U.S.C. 668dd through 668ee)

3. Federal Fire Prevention and Control Act of October 29, 1974 (88 Stat. 1535; 15 U.S.C. 2201)

4. Wildfire Suppression Assistance Act of 1989 (P.L. 100-428, as amended by P.L. 101-11, April 7, 1989)

5. Wildland Cooperative Fire Control Agreement dated July, 1986. Reference IA-2-86-31-019, WY910-CFA6-19

6. Protection Act of September 20, 1922. (42 Stat. 857; 16 U.S.C. 594) authorizes the Secretary of the Interior to protect from fire, lands under the jurisdiction of the Department directly or in cooperation with other Federal agencies.

7. Economy Act of June 30, 1932. (47 Stat. 417; 31 U.S.C. 315) authorizes contracts for services with other Federal agencies.

8. Disaster Relief Act of May 22, 1974. (88 Stat. 143; 42 U.S.C. 5121) authorizes Federal agencies to assist state and local governments during emergency or major disaster by direction of the President.

C. Enabling Legislation and Purpose of the Refuge

Please refer to Chapter 1 of the Draft EIS (this information will be contained in the final Fire Management Plan).

D. Stillwater NWR Complex Management Goals and Objectives

Please refer to Chapter 3 of the Draft EIS (this information will be contained in the final Fire Management Plan).

E. Comprehensive Conservation Plan

At the date of this writing, the Refuge has developed a Draft CCP. The CCP will guide the management of the Refuge into the next Century. The CCP addresses and redefines the Refuge's Goals and Objectives. The goals and objectives identified below were taken from the CC.. The Fire Management Plan is a step-down plan from the CCP.

F. Stillwater NWR Complex Draft Comprehensive Conservation Plan Strategies

Relating to Fire Management (Preferred Alternative)

Management Strategies outlined in the Preferred Alternative of the Draft CCP discuss the use of prescribed fire to achieve Refuge goals and objectives in the following areas.

Vegetative Diversity Strategy. "Development of an integrated pest management plan (IPM), which reduces the reliance on herbicides, for controlling nonnative vegetation. Control tactics may include: flooding or dessication; mechanical treatments (e.g., chainsawing, rooting, disking); prescribed burning (to be addressed in a Fire Management Plan); introduction of host-specific insects; grazing or browsing by goats or sheep to reduce weeds; and herbicides (minimized to the extent possible).

Specific Wildlife Needs Strategy. "The step down Fire Management Plan would include: (1) a prescribed burning program to enhance vegetation for certain species of wildlife, which would include reducing rank vegetation in emergent marches to improve the area for waterbirds that require openings in the vegetation, and enhance goose browse in agricultural fields; and (2) a provision that natural vegetation diversity is emphasized on Stillwater NWR Complex (where natural fires were infrequent), recognizing that the needs of certain wildlife may require prescribed burning outside of this emphasis."

G. Fire Management Goals, Objectives, Strategies, and Limitations

Introduction

Under present day circumstances, over the course of time, prescribed and wild fire will play a role in the management of resources on Stillwater NWR Complex. The Fire Management Plan for Stillwater NWR Complex provides a detailed plan of action to implement fire management goals for the Refuge for the purpose of achieving management objectives. An example of this includes one of the Refuge's guiding principles as identified in the CCP, Preferred Alternative: "An underlying principle in refuge management, under this alternative, would be that mimicking natural processes is a fundamental and necessary part of restoring the biological integrity and health of the ecosystem, and its natural biodiversity." The use of prescribed fire as a management tool will contribute toward the achievement of this goal.

IV. FIRE MANAGEMENT OBJECTIVES FOR STILLWATER NWR COMPLEX

A thorough discussion of the Refuge's goals and objectives can be found in the Draft CCP. Fire specific goals and objectives are indicated below.

A. The General Fire Management Goals

1. Firefighter and public safety is the priority objective of the program. All Fire Management activities will reflect this commitment.

2. Protect life, property, and other resources from wild fire.

3. Use fire as a tool where appropriate to accomplish resource management objectives.

4. Use fire as a tool where appropriate to accomplish Refuge maintenance objectives.

B. Fire Management Objectives

1. Protect from fire all important scientific, cultural, historic, prehistoric, and administrative sites, as well as visitor facilities, and refuge housing.

2. Restore and perpetuate habitat important to migratory and native wildlife species, by maintaining a diversity of plant communities in various successional stages.

3. Employ prescribed fire as a management tool to simulate natural ecological processes.

4. Use fire as a tool to limit the spread and/or facilitate the elimination of noxious weeds.

5. Use fire to facilitate and augment the farm and water management programs.

6. Prevent human-caused wildfires.

7. Educate the public regarding the role of prescribed fire within the Refuge.

V. FIRE MANAGEMENT STRATEGIES

A. Strategies to meet fire management objectives:

1. The Refuge will use the appropriate management response to suppress all wildland fire including lightning ignitions occurring within the boundaries of the Stillwater NWR Complex.

2. Suppress all wildfires in a safe and cost effective manner consistent with resources and values at risk.

3. Suppression strategies and tactics will be unique to each incident dependent on safety considerations, weather conditions, cost of suppression, fuel conditions, availability of resources and location of the fire in relation to structures and cultural resource sites.

4. Minimum impact strategies and tactics will be used whenever possible.

5. Prescribed fire will be used to modify vegetative communities for improved wildlife

habitat, ecosystem function and hazard fuel reduction.

B. Limits to Strategies

1. The use of aerial retardant will be allowed only in non-riparian areas.
2. Hazard reduction prescribed fires may only be used in fire adapted communities that have not had significant fire for more than twice the normal fire frequency for that community type.
3. Use of heavy equipment will be allowed only with the approval of the Project Leader or Resource Advisor.
4. Wildland fire use for resource benefit will not be used.

VI. FIRE MANAGEMENT UNITS (FMU)

All of Stillwater NWR will be considered as one Fire Management Unit (FMU) for wildfire suppression. The Refuge will be divided into five Prescribed Fire Units (Table 5, page 35). The Prescribed Fire Management units will be discussed in Section IX - Prescribed Fire Program.

A. FMU Suppression Objectives

1. Provide for firefighter safety and safety of refuge visitors, cooperators, and personnel.
2. Due to the low frequency of wildfires, the small size of the Refuge staff and the level of physical fitness and training required to staff wildfires; wildfires on the refuge will be suppressed by local cooperators through cooperative agreement.
3. Through local cooperators, the Refuge will use the appropriate management response to suppress all wildland fire including lightning ignitions occurring within the boundaries of the Refuge.
4. Minimize the damage to refuge resources from suppression efforts.
5. Prevent fires from burning off the refuge onto adjacent lands.
6. Prevent damage to cultural resources.

B. Suppression Strategies and Techniques

1. Use existing roads and trails, bodies of water, areas of sparse or non-continuous fuels as primary control lines, anchor points, escape routes, and safety zones.
2. When appropriate, conduct backfiring operations from existing roads and natural barriers to halt the spread of fire.
3. Use burnouts to stabilize and strengthen the primary control lines.

4. If the use of heavy equipment is warranted, upon approval of the Refuge Manager, construction of control lines will border existing roads where possible.

5. Retardants may be used on upland areas.

6. Constructed firelines will be rehabilitated prior to departure from the fire.

7. The Incident Commander will choose the appropriate suppression strategy and technique. As a guide: On low intensity fires (generally flame lengths less than 4 feet) the primary suppression strategy will be direct attack with hand crews and engines. If conditions occur that sustain higher intensity fires (those with flame lengths greater than 4 feet) then indirect strategies which use back fires or burning out from natural and human-made fire barriers may be used. Those barriers should be selected to safely suppress the fire, minimize resource degradation and damage and be cost effective.

. Limits

See V-B for a listing of limits to suppression activity.

. Normal Fire Behavior

Fire behavior is dependent on many factors. Some of the most important influences are relative humidity, air temperature, fuel type, fuel moisture, wind speed, slope, aspect, time of day, and season. On site predictions of estimated fire behavior can be made with the above inputs through the use of nomograms and models developed for this purpose. The various prediction systems provide outputs of rate of spread, fireline intensity, heat per unit area, and flame length.

General statements can be made for fires in certain fuel types.

Fuel Model 1 Grass - describes areas dominated by short grass, such as saltgrass. Rate of spread of 78 chains per hour with flame lengths of four feet are possible under moderate conditions. This fuel model occurs on Refuge farm fields and restored grassland uplands.

Fuel Model 3 Grass - describes areas dominated by grass or grasslike vegetation with an average height of three feet. This would include cured stands of cattail and hard-stem bullrush. Rate of spread of 104 chains per hour with flame lengths of 12 feet are possible under moderate conditions. This fuel model occurs around developed wetlands and some naturally occurring wetlands.

Fuel Model 6 Shrub - describes areas where the shrub layer carries the fire at wind speeds greater than eight miles per hour. Fire drops to the surface layer at lower wind speeds or openings in the stand. This fuel model occurs in extensive upland areas containing greasewood, and several other species of desert shrub. Little if any fine dead fuels may be present, and the shrub layer will only carry a fire under moderate to severe wind speeds. The desert shrub plant community on the Refuge has a patchy, sparse fuel characteristic. Fire will only spread under the most extreme conditions (wind speeds 20 mph or higher). Fires generally stop when they reach the desert shrub zone.

. Use of ERC and BI to Predict Fire Behavior

At the present time the Refuge does not have a weather station, therefore the necessary data has not been collected to accurately determine a fire weather history. Until such time as the refuge purchases and installs a weather station and catalogues site specific data in WIMS, a BLM weather station at a representative site will be used to determine potential fire behavior and trends necessary to properly manage the fire suppression program.

. Relationship of Fire Management Unit to Station Objectives

The Suppression Unit encompasses the entire Refuge. Therefore, the previous discussion of Station Objectives (Sections III) fully addresses the unit objectives for the Suppression Unit.

VII. FIRE MANAGEMENT PROGRAM AND RESPONSIBILITIES

A. Personnel

Position needs of the Fire Management program for both preparedness and prescribed fire at Stillwater NWR Complex are found in Table 3. Due to the low frequency of wildfires (two in the last 10 years), small staff size, and physical fitness and training requirements; wildfires on the Refuge will be suppressed by local cooperators through a cooperative agreement. The Zone Fire Management staff headquartered at Sheldon Hart Mountain Refuge Complex will assist the Refuge with preparedness planning and all prescribed fire planning and operations. Currently, no Stillwater NWR Complex employees are qualified for suppression or prescribed fire operations.

Table 3. Fire Management Needs

Position	Minimum # Required
Suppression Resources from local cooperator via agreement	determined by local cooperator
Prescribed Fire Burn Boss Type 2 (RXB2)	provided by the Zone fire staff for RX
Engine Boss (ENGB) for RX operations	provided by the Zone fire staff for RX
Engine Operator (ENOP) for RX operations	(1) RX fire only
Fire Fighter Type 2 (FFT2) for RX operations	(1) RX fire only
Prescribed Fire Burn Boss Type 3 (RXB3)	(1) refuge burn boss

B. Refuge Staff Responsibilities

The Refuge is remote and has a small staff. All trained and qualified employees will participate to the level of their training and qualifications in fire management activities. Initial attack will be carried out in accordance with Service Policy. Wildfires will be suppressed by local cooperators through a cooperative agreement. Specific responsibilities of Refuge staff and Zone fire Management staff are outlined below.

1. Project Leader

- Will be responsible for the overall management of the Refuge, including the fire program.
- Will ensure that Department, Service, and Refuge policies are followed and maintained.
- Will ensure sufficient collateral duty firefighters meeting Service standards are available for initial attack.
- May serve as prescribed fire burn boss, as available and qualified.
- Will approve prescribed fire plans.

2. Deputy Project Leader

- Will supervise the maintenance and biological staff.
- Will supervise the resource management activities on the Refuge including the selection of objectives and tools to be used in achieving objectives (including prescribed fire).
- May be delegated the responsibility for managing the wildland and prescribed fire programs during the absence of the Project leader.
- Will coordinate with Zone Fire Management Office (FMO) to prepare annual FIREBASE budget request, approves and tracks use of FIREBASE accounts.

3. Zone Fire Management Officer

- Will be responsible for planning, coordinating, and directing preparedness activities including:
    a. Fire training.
    b. Physical fitness testing and Interagency Fire Qualification System (IFQS) data entry.
    c. Fire cache and equipment inventory accountability, maintenance, and operation.
    d. Cooperation with cooperative agencies. Revises cooperative agreements as necessary.
- Will ensure fire management policies are observed.
- Will have lead responsibility for managing the prescribed fire program including:

a. Serve as prescribed fire burn boss.

c. Write prescribed fire plans.

- Will Maintain liaison with Regional Fire Management Coordinator.
- Will update the Fire Management Plan, maintains fire records, reviews fire reports (DI-1202) for accuracy.

3. **Seasonal and Collateral Duty Firefighters IF APPLICABLE**

- Will maintain assigned fire equipment in ready state and use required PPE.
- Will be responsible for their personal protective equipment and physical conditioning.
- Will qualify annually with the work capacity test before April 15.

4. **Wildfire Incident Commander (IC) (as assigned)**

- Will be responsible for the safe and efficient suppression of the assigned fire.
- Will ensure that personnel are qualified for the job they are performing.
- Will ensure that fire behavior is monitored, data collected and recorded.
- Will identify and protect sensitive areas.
- Will use minimum impact strategies whenever possible.
- Will ensure that rehabilitation needs have been considered. is fully
- Will submit information for DI-1202 wildfire report, crew time sheets, and a listing of any other fire related expenditures or losses to Project Leader within 10 days of fire being declared out.

5. **Prescribed Burn Boss (as assigned)**

- Will implement approved prescribed burn plans within prescriptions.
- Will assist with the administration, monitoring, and evaluation of prescribed burns.
- Will document weather and fire behavior (including rates of spread and flame length) and submit to Deputy Project Leader.
- Will document necessary information to complete DI-1202 (fire report) and submit to the Project Leader within 30 days of the fire being declared out.

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C. Fire Cooperators and Interagency Coordination

Stillwater NWR Complex is surrounded by Federal lands owned and/or managed by the Bureau of Land Management, tribal land, and private land. The BLM Carson City District adjoins the Refuge and has primary fire management on their lands. In addition, Churchill County has fire management responsibilities for the entire County.

The Refuge is located within Churchill County. Churchill County Fire Department will suppress wildfires on the Refuge. The Refuge will develop a cooperative agreement with the County in order to clearly identify suppression objectives and limitations.

VIII. WILDFIRE PROGRAM

A. Fire Prevention

1. Fire Prevention Program

Human caused and natural ignitions burning without a prescription are likely to result in unwanted damage to cultural and/or natural resources. In order to prevent wildfire, an educational program will be used to reduce the threat of human caused fires. Ongoing monitoring will be conducted by refuge staff, visitors, and cooperators to detect fire ignitions. Actions taken to implement this include:

a. All staff members will be familiar with this plan. New employees and volunteers will be given an orientation session which includes discussion of fire prevention and detection.

b. Fire prevention will be discussed at safety meetings, prior to the fire season, and during periods of high fire danger. Periodic training of staff in regards to fire prevention will be conducted.

c. During periods of high fire danger, warnings will be posted at visitor information stations.

d. A thorough investigation will be conducted of all fires suspected to have been illegally set. Upon completion of the investigation, appropriate action will be taken

2. Fire Prevention Analysis

A review of fire records indicates that during the period of 1988 to 1998 two fires were human caused. One fire was from an adjacent landowner burning ditches, the other fire was human caused of unknown origin. An analysis has not been completed due to the insignificant number of human caused ignitions. If ignitions significantly increase or begin to occur in new areas, prevention strategies will be reviewed and modified, if necessary. As new visitor facilities are developed or use levels significantly increase, the fire plan will be reviewed and modified if necessary.

B. Fire Season

Due to the low frequency of wildfires, a wildfire season is not evident. Fuels are generally cured during the months of July through March. Wildfires may occur during any of these months. Green up is usually in April through June, during which time fuels are not available to sustain fire spread. Most wildfires in the area are associated with escaped agricultural burns.

C. Fire Behavior

Fire behavior is dependent on many factors. Some of the most important influences are relative humidity, air temperature, fuel type, fuel moisture, wind speed, slope, aspect, time of day, and season. On site predictions of estimated fire behavior can be made with the above inputs and provide outputs of rate of spread, fireline intensity, heat per unit area, and flame length through the use of nomagrams developed for this purpose.

General statements can be made for fires in certain fuel types.

Fuel Model 1 Grass - describes areas dominated by short grass, such as saltgrass. Rate of spread of 78 chains per hour with flame lengths of 4 feet are possible under moderate conditions. This fuel model occurs on farm fields and restored uplands.

Fuel Model 3 Grass - describes areas dominated by grass or grasslike vegetation with an average height of three feet. This would include cured stands of cattail and bulrush. Rate of spread of 104 chains per hour with flame lengths of 12 feet are possible under moderate conditions. This fuel model occurs around developed wetlands and some naturally occurring wetlands.

Fuel Model 6 Shrub - describes areas where the shrub layer carries the fire at wind speeds greater than 8 miles per hour. Fire drops to the surface layer at lower wind speeds or openings in the stand. This fuel model occurs in extensive upland areas containing greasewood, and several other species of desert shrub. Little if any fine dead fuels may be present, and the shrub layer will only carry a fire under severe wind speeds.

Wildfire can be dangerous and unpredictable during any season of the year, however the months of August and September typically have the potential for the most severe fire behavior. During these months, fine fuels and other plants have cured out, relative humidity is usually low, temperatures are the highest of the year, wind speeds are typically high in the afternoon, ignition sources however are uncommon.

D. Preparedness

1. Training and Qualifications

Service policy sets training, qualification and fitness requirements for all wildland firefighters and prescribed fire positions. All personnel involved in fire management functions will be provided with the training required to meet Service qualification standards for the position they are expected to perform. Interagency training opportunities will be used whenever possible.

a. Training

The Regional Office will pay for all approved fire training if the following criteria are met:

1. Participant completes and submits to the Zone FMO a National Wildfire Coordinating Group Interagency Training Nomination form (NFES 2131), complete with supervisory approval and an estimated cost of training, travel and per diem prior to the commencement of training.

2. The training is approved by the Regional Fire Management Coordinator.

3. Upon completion of the training, a copy of the Certificate of Completion and a copy of the travel voucher are sent to the Budget Assistant for Refuges and Wildlife in the Regional Office.

2. Annual Refresher Training

All personnel involved in Fire Management activities are required to participate in 8 hours of fire management refresher training annually in order to be qualified for fire management activities in that calendar year. Refresher training will concentrate on local conditions and factors, the Standard Fire Orders, LCES, 18 Situations, and Common Dominators. Northwest Coordination Group (NWCG) courses Standards for Survival, Lessons Learned, Look Up, Look Down, Look Around, and others meet the firefighter safety requirement; but, efforts will be made to vary the training and use all or portions of other NWCG courses to cover the required topics. Fire shelter use and deployment under adverse conditions, if possible, must be included as part of the annual refresher.

3. Physical Fitness

All personnel involved in fire management activities will meet the fitness standards established by the Service and Region. At time, firefighters participating in wildfire suppression must achieve and maintain an Arduous rating. Firefighters participating in Prescribed Burns must achieve and maintain a Moderate rating. A trained and qualified American Red Cross Responder (or equivalent) who can recognize symptoms of physical distress and provide appropriate first aid must be on site during the test.

Wildland fire fitness tests shall not be administered to anyone who has obvious physical conditions or known heart problems that would place them at risk. All individuals are required to complete a pre-test physical activity readiness questionnaire prior to taking a physical fitness test. They must read and sign the Par-Q health screening questionnaire, an informed consent form. If an employee cannot answer NO to all the questions in the PAR-Q health screening questionnaire, or is over 40 years of age, unaccustomed to vigorous exercise, and testing to achieve a Moderate or Light rating, the test administrator will recommend a physical examination. As noted below, all individuals over 40 must receive an annual physical prior to physical testing.

4. Physical Examinations

All individuals involved in arduous fire management activities over the age of 40 or newly hired are required to complete an annual physical fitness examination. Standard forms and procedures required by the Service will be used and followed. The cost of examination will be born by the Service and the results will be sent to the Region Personnel Department.

5. Annual Refuge Fire Management Activities

Table 4: Annual Refuge Fire Management Activities

ACTIVITY	1	2	3	4	5	6	7	8	9	10	11	12
Update Interagency Fire Agreements/AOP's	x											
Annual Refresher Training	x											
Annual Fitness Testing	x											
Prescribed Fire Plan Preparation											x	
Review and Update Fire Management Plan				x								
Prepare Pre-season Risk Analysis			x									

Activities should be completed prior to the end of the month indicated. These activities will be conducted by the Zone Fire Management Staff.

6. Emergency Preparedness

Prescribed fire activities will not be conducted when the National Preparedness is at Levels IV or V, with out approval of the Great Basin Coordinating Group.

E. Normal Unit Strength

1. Engines, tools, and other equipment

Engines are the primary initial attack resource on the Refuge because of the predominance of fine fuels and access roads. Earth moving equipment is available, however it will only be used after approval of the Project Leader or Resource Advisor.

Churchill County Fire resources will be used to suppress wildfires on the Refuge.

2. Personnel

A listing of required positions for wildfire management activities can be found in Section III, Table 4. Churchill County fire resources will be the primary suppression resources during wildfire incidents. The Refuge will provide non arduous support in the form of Resource Advisors.

F. Severity Funding

Severity funding may be essential to provide adequate fire protection for the Refuge during periods of drought, as defined by the Palmer Drought Index or other appropriate drought indicator. Severity funds may be used to hire additional firefighters, extend firefighter seasons, or to provide additional resources. The Service Fire Management Handbook provides guidelines for use of severity funding.

G. Detection

The Refuge relies on neighbors, visitors, cooperators, and staff to detect and report fires.

H. Fire Suppression

1. General

Service policy requires the Refuge to utilize the ICS system and firefighters meeting NWCG qualifications for fires occurring on Refuge property. All suppression efforts will be directed towards safeguarding life while protecting the Refuge's resources and property from harm. Mutual aid resources responding from cooperating agencies will not be required to meet NWCG standards, but must meet the standards of their agency.

2. Initial Reporting and Dispatching

All fires occurring within the Refuge will be reported to the Churchill County Fire Dispatch. The person receiving the report will be responsible for implementing the Fire Dispatch Plan . The Zone Fire Staff at Sheldon Hart Mountain NWR Complex will be able to assist with managing an extended attack incident.

Requests for assistance by cooperators on fires not threatening the Refuge must be made to the Project Leader or designee. Only qualified and properly equipped resources meeting NWCG standards will be dispatched off the Refuge.

3. Communications

Refuge vehicles have mobile radios capable of communicating with local fire suppression resources.

4. Initial Attack

All fires occurring on the Refuge will be supervised by a qualified IC. The IC will be responsible for all management aspects of the fire. All resources will report to the IC (either in person or by radio) prior to deploying to the fire and upon arrival at the fire. The IC will be responsible for: (1) providing a size-up of the fire to dispatch as soon as possible; (2)

determining the resources needed for the fire; and (3) advising dispatch of resource needs on the fire.

The IC will receive general suppression strategy from the Fire Management Plan, but implementation of the appropriate tactics used to suppress the fire will be up to the IC. Minimum impact suppression tactics (MIST) will be used whenever possible.

5. Escaped Fires/Extended Attack

Whenever it appears a fire will escape initial attack efforts, leave Service lands, or when fire complexity exceeds the capabilities of command or operations, the IC will take appropriate, proactive actions to ensure additional resources are ordered. The IC, through dispatch or other means, will notify the Zone FMO of the situation. The Zone FMO will assist the Project Leader to complete a Wildland Fire Situation Analysis (WFSA) and Delegation of Authority.

6. Mop up and Rehabilitation

The IC will be responsible for mop-up and rehabilitation actions on Refuge fires. Refuge fires will be monitored until declared out.

7. Limits to Suppression Activities

The use of earth moving equipment for suppression activities (dozers, graders, plows) on the Refuge will not be permitted without the approval of the Resource Advisor (Refuge employee).

I. Rehabilitation

Rehabilitation of suppression actions will take place prior to firefighters being released from the fire. Actions to be taken include:

- All trash will be removed.
- Firelines will be refilled and waterbars added if needed.
- Damage to improvements caused by suppression efforts will be repaired, and a rehabilitation plan completed if necessary. Service policy states that only damage to improvements caused by suppression efforts can be repaired with fire funds. Service funds cannot be used to repair damage caused by the fire itself (i.e. burnt fence lines). If re-seeding is necessary, it will be accomplished according to Service policy and regulations.

J. Records and Reports

The IC on a wildland fire or the prescribed fire burn boss on a prescribed burn will be responsible for the information needed for a DI-1202 Fire Report as well as Crew Time Reports for all personnel assigned to an incident and return these reports to the Project Leader. The IC or burn boss should include a list of all expenses and/or items lost on the fire and a list of personnel assignments on the DI-1202. The Zone FMO will enter all data into the FMIS computer database within 10 days after the fire is declared out. The Project Leader will inform the timekeeper of all time and premium pay to be charged to the fire and ensure expended supplies are replaced.

IX. PRESCRIBED FIRE PROGRAM

A. Introduction

Prescribed fire has been used on a limited basis on the Refuge primarily to facilitate the accomplishment of maintenance operations such as; irrigation ditch maintenance, farm field preparation, pile burning, and weed control.

Prescribed fire has also been used to remove dead emergent wetland vegetation that was impairing productivity of wetlands. Historical files on prescribed fire activities were not maintained. Long-term Refuge employees say that fire has been an effective method in managing maintenance operations and the habitat management program.

Prescribed fire has not been used in the recent past due to changes in Federal, Department, and Service policy regarding physical fitness and training. Refuge staffing levels and general workload have not allowed time to meet new policy and standards. Fire program management at Stillwater NWR Complex is now largely the responsibility of the Zone Fire Management Staff located at Sheldon Hart Mountain NWR Complex in Lakeview, Oregon. This program has increased to the level where Zone Fire Management Staff (in concert with Refuge support) will now be capable of handling the Stillwater NWR Complex prescribed fire program needs. Zone fire staff will plan and conduct all prescribed burns on the Refuge. Stillwater NWR Complex staff will assist when and where possible. In the future, the Refuge will strive to maintain one or more Prescribed Burn Boss Type 3 (RXB3) on the staff.

B. The Use of Prescribed Fire to Achieve Resource Management Goals

As a result of the CCP process it has been affirmed that the use of prescribed fire is an appropriate management tool. Prescribed burning will be used to restore, create, and/or maintain a diversity of plant communities to perpetuate native plant and wildlife species. The goals of the prescribed fire program are:

1. Restoration/perpetuation of native grass, forb, and shrub species.

2. Reduction of nonnative species (to either injure the plant or prepare it for other control such as mechanical, herbicide, grazing, etc).

3. Reduction, periodically, of dense cattail growth in wetland units.

4. Maintenance/rejuvenate of nesting cover for waterfowl and other native birds.

5. Maintenance of water delivery systems and the farm program. Primarily burning: stubble in preparation of planting, weed control, burning irrigation ditches, and burning debris piles.

Achieving many of the goals will require repeated burn cycles for an indefinite length of time. Burn frequency will vary from every 1 to 10 years dependent on management objectives, historic fire frequency, and funding. As part of the prescribed fire program, a monitoring program will be instituted to verify that objectives are being achieved.

C. Fire Management Units

Prescribed fire will be used in three areas of the Stillwater NWR Complex:

1. Restored Native Uplands: These fields are lands reclaimed from past agricultural operations. They are managed extensively for habitat restoration. The intent is to convert these acres from agricultural uses and re-introduce native grass species. Maintenance burns on a rotational basis will be applied.

2. Wetlands: Shortgrass/meadow, short emergent, tall meadow - all grouped together as wetlands. The intent is to manage for mosaics of wetland vegetation.

3. Maintenance Burns: Ditches, stubble, patches of weeds, piles of debris

The Refuge will be divided into three prescribed fire management units (Table 5). The units were created using habitat types under the basic assumption that each habitat presents its own unique fire behavior, objectives, and prescription values.

A general discussion of anticipated fire behavior based on fuel models can be found in Section VIII.

Table 5: Prescribed Fire Management Units

Unit	Total Acreage	Burn per year
Wetlands		75-100 acres
Restored Native Uplands	400-500	65-125 acres
Maintenance (stubble, piles, ditches)		100-150 acres

Fire Effects in Restored Native Uplands:

Prescribed fire will be used to help restore fields once used for agricultural purposes to a more natural state. Fields will be burned for several purposes: at the start of the restoration process to eliminate weeds and annuals while at the same time preparing a seed bed, and for periodic vegetation maintenance after establishment of planted native grasses. Native grasses, selected for their ability to thrive in salt or alkali rich soils, resist prolonged drought, and are fire adaptive.

The native bunch grass species planted on restored agricultural fields on Stillwater NWR Complex are listed below along with a brief statement about how fire affects each

1. Western Wheat Grass (Pascopyrum smithii) - Fire usually consumes the dry vegetative component of this grass to ground level, but it usually revegetates rapidly from rhizomes after fires. Spring burns, before new growth is initiated, favor western wheatgrass, increasing plant abundance and density. Fall burning also stimulates productivity but to a lesser degree. Fire can cause severe injury to this plant during its growing period, from late spring through the summer, resulting in less above-ground foliage and reduced below-ground rhizome growth.

2. Creeping Wild Rye (Elymus triticodes) - Not a lot of information on how fire affects this grass is available, but it appears to be reasonably well adapted to fire due to a rhizomous root system. Fire generally consumes all above-ground foliage, but the plant apparently survives by sprouting from rhizomes.

3. Great Basin Wild Rye (Leymus cinereus) - This grass is well adapted to fire. When fire burns this grass, coarse, dense stems tend to insulate basal buds located near ground level from the damaging heat of even high-intensity fires. Most individuals readily survive fire, sprouting from basal buds or rhizomes as well as establishing postfire seedlings. Rapidity of recovery is related to season and severity of burn. Burning during periods of dormancy appears to be most conducive to the rapid recovery of this grass. Generally less damaged by fall-season fires, this grass also recovers almost as rapidly from spring-season fires as well. Basal buds can be destroyed by very intense, summer fires.

4. Alkali Sacaton (Sporobolus airoides) - This grass is generally considered fire tolerant. Fires usually consume dry aboveground parts to ground level. Little downward transfer of heat into belowground plant parts occurs. Alkali sacaton regenerates via seeds and spreads via tillers.

Fire Effects in Wetlands. Fire effects are generally well documented and predictable.

D. Hazardous Fuel Reduction

Prescribed burns may be conducted within or near Refuge development zones, sensitive resources, and boundary area to reduce the risk from wildfire damage. To the greatest extent possible, hazard reduction prescribed fires will only be used when they complement resource management objectives.

E. Planning

The Refuge Project Leader is responsible for supervising the development of resource management objectives for individual units. The Refuge staff will provide assistance in the selection of the appropriate management tool needed to meet objectives. Prescribed fire is just one of a combination of available tools. The Zone FMO and zone fire management staff will be consulted for assistance in developing a prescription that will achieve the desired results.

A burn plan will be written that will document the treatment objectives, the prescription, and the plan of action for carrying out the burn. Burn plans will also identify resource concerns and any mitigation or special precautions necessary to alleviate potential detrimental fire effects. Burn plans can be written by any qualified burn boss. The burn plan will follow the format in the Service Fire Management Handbook or a format approved by the Regional Fire Management Coordinator and address all aspects as specified in the Service Fire Management Handbook. All burn plans will be reviewed by the Refuge Manager, and Zone FMO, and approved by the Refuge Project Leader prior to implementation.

F. Preparation and Implementation

Preparation of prescribed burn units will be handled on an individual basis with site preparation identified in the burn plan for that unit.

Prescribed burns can be conducted at any time of year depending on resource objectives and prescription; however, the normal prescribed fire season is during the fall, winter and spring, when vegetation is dormant and cured and prior to breeding season.

G. Limits

Stillwater NWR is located in the Western Great Basin Geographic Area. Prescribed fires cannot be ignited when the Western Great Basin Geographic Area is in a fire danger Preparedness Level V and/or the National Preparedness level is V, without the approval of the Western Great Basin Geographic Area Coordination Group.

Drought can have an effect upon fire severity and control. One or more drought indicators (PDI - KBI) will be used to determine the degree of drought. These indicators can be accessed on the web at *http://www.boi.noaa.gov/fwxweb/fwoutlook.htm*

H. Complexity

Prescribed fire complexity on Stillwater NWR will be determined by the Service Fire Complexity Analysis. All prescribed fires currently being considered are of low to moderate complexity.

I. Monitoring and Evaluation

1. Introduction

Past monitoring and evaluation of prescribed fires has been limited due to funding and staffing limitations. Pre-burn evaluation was limited to general photographs and/or qualitative evaluation of fuel conditions and green up conditions. Burn day evaluations documented weather (many times not on site) and limited documentation of fire behavior. Subjective measurements (visual) such as the percent of fuel consumed were also made. Post burn evaluation was limited to subjective qualitative estimates of species response and effectiveness in achieving objectives.

Although little site specific data on fire effects for Stillwater NWR Complex exists, general conclusions can be made from the Fire Effects Information System.

Fire monitoring protocols for the Region or Service will be used at Stillwater NWR Complex. Protocols will be established to determine if burn objectives are being met and to monitor long-term vegetation responses. Fire monitoring will be consistent with monitoring goal and objectives identified in preferred alternative of the Draft CCP.

2. First Order Fire Effects Monitoring Program

- **Environmental Conditions** will periodically be recorded at the site prior to ignition and hourly during the burn. Conditions to be evaluated will include air temperature, relative humidity, and wind speed and direction.
- **Fuel moisture(s)** will be measured or estimated using tables, charts, or other prediction system (BEHAVE).
- **Fire Behavior** such as flame length and rates of spread will be recorded.
- **Post fire effects** will be measured or estimated. These effects include scorch height, percent of area burned, percent of fuel consumed - based on fuel (time-lag) classification, amount of duff removed, etc.

J. Prescribed Fire Impacts

1. Environmental Impacts

Environmental impacts of the prescribed fire program have been discussed in previous sections of this Fire Management Plan. Air quality issues will be discussed in Section XI.

2. Social and Economic Impacts

Stillwater NWR Complex lies entirely within Churchill County, Nevada. The public has generally been supportive, the timing of some burns during hunting seasons could result in some public opposition to these prescribed burns. The community of Fallon exists approximately 14 miles southwest of the Refuge. It is unlikely that prescribed burns conducted on the refuge would be largely opposed.

The majority of recreational use occurring on Stillwater NWR Complex is centered around hunting, and wildlife observation. Visitors from all over the area come to participate in wildlife dependent recreational opportunities on Stillwater NWR Complex. Annual visitation is estimated at 34,000 per year. Negative impact to the local economy could result if habitat conditions decline resulting in decreases in wildlife populations. The number of visitors traveling to the area could decrease; thus, reducing income for the local economy.

Escaped prescribed fire poses a threat to adjacent life and property. However, proper planning, prescriptions, use of qualified personnel, and contingency planning will mitigate this threat.

X. WILDLAND FIRE USE FOR RESOURCE BENEFIT

Stillwater NWR Complex has chosen not to use wildland fire use for resource benefit primarily because natural ignitions are too infrequent.

XI. AIR QUALITY AND SMOKE MANAGEMENT GUIDELINES

As of the writing of this plan, the State of Nevada is in the process of developing a State Smoke Management Plan to address air quality issues.

There are no non attainment areas near the Refuge. Smoke sensitive areas in the area include Refuge, County, and State roads. The community of Fallon, Nevada. (population 10,000) is approximately 14 miles southwest of the refuge. The Fallon Naval Air Station is approximately 15 miles south of the Refuge. Private and Tribal lands adjacent to the Refuge are primarily agricultural with some single family residences. Agricultural burning in and around the Refuge is widespread, frequent, and commonly accepted by the public.

Prescribed fire operations will be conducted in compliance with the Nevada State Smoke Management Plan. Individual prescribed burn plans will specifically address smoke management concerns and actions required to ensure public safety and prevent negative impacts from smoke. The public will be informed of prescribed fire activity on the Refuge through several methods including: in person or telephone notification of nearby neighbors, Refuge press releases, information bulletins posted at information kiosks, smoke signs and traffic control devices. Tribal, military, and county entities will be contacted prior to burning by phone or in person as part the required elements of each prescribed burn plan.

Burn plans will also include contingency plans which will be implemented in the event of unexpected negative smoke dispersal conditions. In general, prescribed burns will be small (average 50 to 100 acres), have light fuel loads (.25 to 3 tons of fuel per acre), will be burned under low fuel moisture conditions, and will be burned under specific wind direction and atmospheric stability conditions.

Prescribed burns on the Refuge fall into the Prescribed Fire Units: wetlands, restored native uplands, and maintenance. The table below illustrates representative PM 10 emissions in tons per average burn.

Table 6. Prescribed Fire Emissions

Burn Type	Average Size of Burn	PM10 Emissions per Burn
wetland	75 acres	2.25 tons
restored native upland	30 acres	.45 tons
maintenance	20 acres	.1 tons

XII. FIRE RESEARCH AND MONITORING

Research on fire effects within Refuge boundaries has been limited to observations by Refuge staff.

Monitoring will comply with accepted scientific methods. Fire behavior data will be collected on all prescribed fires occurring on Stillwater NWR Complex as outlined above. The data recorded, along with information gathered through research studies in similar plant communities, will be used to improve the effectiveness of the fire management program. The Refuge will continue to encourage fire related research on Service lands where research operations will not conflict with resource management objectives.

No specific fire research needs have been identified at this time.

XIII. PUBLIC SAFETY

Firefighter and public safety always take precedence over property and resource protection during any fire management activity.

Under moderate to severe fire danger index ratings, flaming fronts are capable of moving at fast speeds in all fuel models. In order to eliminate safety hazards to the public, all public access into the burn units will be closed the day of the burn. Fire crews will be briefed that should an individual who is not a member of the fire crew be observed in the prescribed burn unit, they will be immediately escorted out of the area.

During wildfires, the IC is responsible for managing hazards from smoke. Smoke mitigation and management will be included in the prescribed burn plan and is the responsibility of the burn boss. Smoke from a Refuge fire could impair visibility on roads and become a hazard. Actions to manage smoke include; use of road guards and pilot car, signing, altering ignition techniques and sequence, halting ignition, suppressing the fire, and use of local law enforcement as traffic control.

Wildfires which might escape Service land and spread to inhabited private property are also a concern. The IC is responsible for warning and evacuating the public from potentially dangerous situations.

XIV. PUBLIC INFORMATION AND EDUCATION

Informing the public is an important part of fire suppression, fire prevention, prescribed fire, and the Service mission. Information and education are critical to gaining public support for the Refuge's fire management programs. There are several different aspects to this task.

A. Wildfire Suppression

During wildfire suppression, the IC is responsible for getting information to the press and the public. The IC may delegate this responsibility as appropriate.

B. Prescribed Fire

Informing the public is a vital component of the prescribed fire program. Areas that have been burned will present opportunities for the public to actually see the effects of fires, and offer staff members an opportunity to explain the purpose of the burns to the public. The following will be used to promote the prescribed fire program to the public:

1. Presentations in local schools.
2. Attendance at local fire department meetings.
3. Include a prescribed fire message in Refuge interpretive publications and materials.

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4. Follow prescriptions in burn plans to prevent escapes.

XV. ARCHEOLOGICAL/CULTURAL/HISTORIC RESOURCES

Please refer to the Draft EIS for more information.

Archeological, cultural, and historic resources have been identified through surveys conducted on the Refuge. Information gained from surveys will be used in developing prescribed fire plans and wildfire suppression tactics. Wildfires present a threat to sites located on the Refuge. Appropriate measures will be taken to protect sites during wildfire suppression efforts.

The use of earth moving equipment poses a threat to cultural resources found below the ground surface. The use of earth moving equipment for suppression activities within the Refuge must be approved by the Refuge Project Leader or Resource Advisor on a fire-by-fire basis, and the possible presence of cultural resources will be considered in the approval process. Whenever possible, efforts will be made to contact the Regional Archaeologist to discuss the consequences of the use of earth moving equipment prior to the deployment of the equipment on the fire.

Planning for prescribed burns will include a review of known sites that may be impacted. An index of known sites is maintained by the Regional Archeologist in Portland, Oregon. Known sites or newly discovered sites will be protected from negative impacts. Prescribed burns in the Wetlands Prescribed Burn Unit are the most likely to contain sites due to less modern day disturbance. The Upland Restoration and Maintenance Units have been heavily disturbed during modern times through cultivation, plowing, excavation, etc. Soil disturbance associated with control lines will not be permitted until the area is cleared by a Service approved cultural resources technician.

XVI. FIRE CRITIQUE AND PLAN REVIEW

A. Fire Plan Review

The Fire Management Plan will be reviewed annually to ensure the fire program advances and evolves with the Service and the Refuge's mission and updated as necessary.

B. Wildfire Critique and Review

Wildfires will be critiqued by the IC. The Regional Fire Management Coordinator will conduct formal critiques in the event of:

- Significant injury, accident or fatality

- Significant property or resource damage.

- Significant safety concerns are raised.

C. Prescribed Fire

Prescribed fires will be critiqued by the Burn Boss and documented in the 1202. The Regional Fire Management Coordinator will conduct formal critiques in the event of:

- Significant injury, accident, or fatality.
- An escaped prescribed fire occurs.
- Significant safety concerns are raised.
- A significant smoke management problem occurs.

XVII. CONSULTATION AND COORDINATION

This information will be contained in the final Fire Management Plan.

APPENDIX L:
Literature Review: Effects of Human Disturbance on Wildlife with Emphasis on Wildlife-Dependent Recreation Relevant to Stillwater NWR

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Literature Review: Effects of Human Disturbance on Wildlife with Emphasis on Wildlife-Dependent Recreation Relevant to Stillwater National Wildlife Refuge

by: Anita K. DeLong and Janet T. Schmidt
Stillwater National Wildlife Refuge

The newly-enacted National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57) directs that opportunities be made available within the National Wildlife Refuge System (System) for hunting, fishing, wildlife observation and photography, and environmental education and interpretation when compatible with the mission of the System and the purposes of the refuge. A compatible use was defined in the National Wildlife Refuge System Improvement Act as "...wildlife-dependent recreational use or any other use of a refuge that, in the sound professional judgement of the Director, will not materially interfere with or detract from the fulfillment of the mission of the [System] or the purposes of the refuge." The Congressional Committee Report specifies that compatible uses are those not having "a tangible adverse impact on Refuge System resources." Although the wildlife-dependent recreational uses listed in the National Wildlife Refuge System Improvement Act have been found to be generally compatible uses of the System, the Congressional Committee Report recognized that compatibility may depend on the level or extent of use on a given refuge, and that any or all of the priority public uses may be determined incompatible on any given refuge.

This report was prepared in recognition that such compatibility determinations "are inherently complex," which requires the consideration of "principles of sound fish and wildlife management" and "available science" (House of Representatives Report 105-106). The Congressional Committee Report recognized that conflicts between and impacts of the priority public uses can be minimized by appropriately designing a public-use program that separates uses in time and space, or otherwise regulates human activity. Designing a public-use program to minimize adverse impacts to fish, wildlife, plants, and habitat requires an understanding of the impacts, both independently and cumulatively. The following description of national and international studies examining the effects of human activity on fish, wildlife and habitat serves as a reference for constructing compatibility determinations for Stillwater NWR and may be helpful in designing a public-use program compatible with wildlife. However, this document does not in itself establish compatibility determinations for Stillwater NWR. Compatibility determinations for uses on individual National Wildlife Refuges assesses and analyzes information based on refuge specific data, research, activity level or extent, activity location, activity duration in relation to wildlife distribution, abundance and species habitat needs in addition to professional judgement based on professional wildlife experience, published scientific information, and principles of sound fish and wildlife management. This review primarily presents peer reviewed information that pertains to wildlife species, habitats and activities that are relevant to Stillwater NWR and may be relevant to other similar National Wildlife Refuges.

In general, human activity causes disturbance to wildlife and wildlife habitat at varying degrees depending on the type of human activity, intensity of activity, timing of the activity, number of activities occurring simultaneously, and wildlife species impacted. Human disturbance as defined by Morton (1995) is any intentional or unintentional anthropogenic action that elicits a metabolic or behavioral response. Most studies have documented immediate, rather than long-term responses to disturbance because long-term impacts are inherently more difficult to determine. Immediate responses can be either

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death or behavioral changes including nest abandonment, change in food habits, and physiological changes, such as elevated heart rates due to flight (Knight and Cole 1995). Human disturbance (one cause alone or many types acting synergistically) may reduce the overall carrying capacity of a given staging area for waterfowl and other waterbirds (Pfister et al. 1992). Disturbances may affect an individual's energy balance (Fredrickson and Drobney 1979), and in the long-term may affect an individual's productivity or survival (Knight and Cole 1995).

Based on Dahlgren and Korschgen's (1992) review of 211 waterfowl/human interaction publications, hunters, boats, pedestrians, researchers, anglers, aircraft, and general recreational activities, listed in decreasing order of citations, are important disturbance sources (Dahlgren and Korschgen 1992, Morton 1995, Table 1). Boyle and Samson (1985) in their review of 166 articles examining non-consumptive recreation and wildlife reported negative impacts in more than 81 percent of the articles. Negative effects were reported most commonly for boating, wildlife observation and photography, and hiking and camping, listed in decreasing order of citations (Table 2). Morton (1995) suggested that "the relative importance of different disturbances to waterfowl, at least from the perspective of researchers, can be inferred from the number of times a disturbance is identified in published literature (Dahlgren and Korschgen 1992)."

"The management of National Wildlife Refuges by the U.S. Fish and Wildlife Service requires, among other considerations, maintaining a careful balance between public use and wildlife conservation." (Purdy et al. 1987). This balance is sometimes difficult to obtain. Managers of 16 NWRs in northeastern United States reported lowered productivity, aberrant behavior, reduced use of preferred habitat, reduced use of refuge lands, and mortality to be consequences of human disturbance on their refuges (Purdy et al. 1987).

Purdy et al. (1987) described six categories of impacts to wildlife as a result of visitor activities: (1) direct mortality: immediate, on-site death of an animal; (2) indirect mortality: eventual, premature death of an animal caused by an event or agent that predisposed the animal to death; (3) lowered productivity: reduced fecundity rate, nesting success, or reduced survival rate of young before dispersal from nest or birth site; (4) reduced use of refuge: wildlife not using the refuge as frequently or in the manner they normally would in the absence of visitor activity; (5) reduced use of preferred habitat on the refuge: wildlife use is relegated to less suitable habitat on the refuge due to visitor activity; (6) aberrant behavior/stress: wildlife demonstrating unusual behavior or signs of stress that are likely to result in reduced reproductive or survival rates. Purdy et al. (1987) suggested that refuge managers could use the categories of impact to classify effects of visitor use and to determine compatibility of visitor use with wildlife use of refuges.

Knight and Cole (1991) present a conceptual model of responses of wildlife to recreation activities. In this model, causes of wildlife impacts associated with recreational activity are harvest, habitat modification, pollution, and disturbance. The immediate response by wildlife to recreational activity are behavioral changes or death. The long-term effects on individuals are altered behavior, vigor, productivity, or death; the long-term effects on populations are altered abundance, distribution, or demographics; and the long-term effects on the communities are altered species composition and interactions. Knight and Cole (1991) recommend that managers keep wildlife impacts to acceptable levels by modifying the factors that influence the nature, frequency and magnitude of responses. The magnitude of the avoidance response may depend on the type of activity, timing, location, frequency, predictability, and characteristics of the wildlife species being disturbed.

Table 1. Number of citations on the 10 most frequent sources of human disturbances of waterfowl in 211 journal articles (adapted from Dahlgren and Korschgen 1992).

Hunting	71
Boating	66
Human activity (pedestrians)	58
Research/investigator	55
Fishing	55
Aircraft	47
Recreation: general & aquatic	43
Development	24
Noise	22
Roads/traffic	21

Table 2. Number of citations in 166 journal articles on "nonconsumptive" outdoor recreation impacts on wildlife (Boyle and Samson 1985).

	Impact birds			Impact mammals			Impact herpetofauna		
Type of recreation	+	-	0	+	-	0	+	-	0
Hiking and camping	4	17	6	5	24	4			
Boating		25	9		1	2		1	
Wildlife observation and photography		19	2	1	5	4			
Off-road wheeled vehicles		7	2		5	2		7	1
Swimming and shore recreation		6	2						
Spelunking					8				
Rock climbing		2	3		1	1			
Snowmobiles		1	1	1	7	3			

+ denotes positive impacts, - denotes negative impacts, 0 denotes no impact or impacts undetermined

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While the scientific literature documents impacts of human disturbance on wildlife, the demand for wildlife dependent recreation is increasing. In 1996, an estimated 14 million hunters (including migratory birds and large/small game) and 62.9 million wildlife watchers (including feeding, photographing, and observing wildlife) participated in wildlife related activities in the United States (USDOI et al. 1997). Public support for fish, wildlife and habitat conservation is essential. For example, the water rights acquisition program at Stillwater NWR, authorized under Title II of the Truckee-Carson-Pyramid Lake Water-Rights Settlement Act of 1990 (Public Law 101-618 section 206(a)), very well may not have come to fruition without the dedicated support of the Lahontan Wetlands Coalition. This coalition is comprised primarily of the Nevada Waterfowl Coalition, the Toiyabe Chapter of the Sierra Club, the Lahontan Audubon Society, and the Friends of Pyramid Lake. Without this precedent setting legislation that authorized and directed the acquisition of water rights for the Lahontan Valley wetlands, the wetlands at Stillwater NWR would likely be jeopardized.

As crucial as the contributions of fish and wildlife enthusiasts are to wildlife conservation, it is important to recognize that wildlife-dependent recreational activities can have negative impacts to wildlife and wildlife habitats. It is necessary, therefore, to manage human disturbance when developing a public-use plan. As noted by Morton (1995), "managing human disturbance requires an appreciation of disturbance as a complex phenomenon, a basic understanding of how disturbance affects waterfowl, and a willingness to prohibit or regulate some human activities that may negatively impact waterfowl." Similarly, Bias et al. (1997) noted that "one major and often manageable factor that greatly influences waterfowl use is human disturbance. Disturbance is an important component of waterfowl habitat quality and can affect bird use". Bias et al. (1997) concluded that "controlling disturbance can have both short and long-term benefits for landowners and waterfowl. By reducing the frequency and proximity of disturbance, landowners will experience greater bird use on their properties during the season and create favorable conditions to which birds will return in following days, months, and years. Hunters and other wildlife enthusiasts will have more opportunities to enjoy the birds, and waterfowl will benefit from obtaining the resources that undisturbed habitat types provide leading to greater reproductive potential." Although Morton and Bias et al. specifically identified waterfowl, the management of human disturbance would benefit wildlife in general.

The purpose of this literature review is to identify effects of human disturbance on fish, wildlife and wildlife habitat relevant to Stillwater NWR, with emphasis on the priority wildlife dependent recreational uses (hunting, fishing, wildlife observation, photography, and environmental education and interpretation) and associated activities, and to identify management considerations to reduce human disturbance. The challenge in developing the Stillwater NWR Comprehensive Conservation Plan will be to design a quality wildlife-dependent recreational program without compromising the refuge's purposes of restoring natural biodiversity and conserving wildlife and wildlife habitat.

General Response of Wildlife to Disturbance

According to Knight and Cole (1991), responses by wildlife to human disturbance are: (1) avoidance; (2) attraction; and (3) habituation. The magnitude of the avoidance response may depend on a number of factors including the type, distance, movement pattern, speed, and duration of the disturbance, as-well-as the time of day, time of year, weather, and the animal's access to food and cover, energy demands, and reproductive status. Gabrielsen and Smith (1995) characterized the "active defense response" or "fight or flight response" by birds and mammals as the physiological response which includes increased heart rate and respiration, increased respiration depth, increased blood flow to skeletal muscle, brain, and heart, increased oxygen consumption, increased body temperature, elevation of blood sugar, increased metabolism and reduced blood flow to the skin and digestive organs. Most of these physiological

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responses involve the release of adrenaline and each improves the chances of survival under conditions where prolonged strenuous activity might be necessary, as in fighting or fleeing. For example, blood sugar is increased to support prolonged activity. Blood flow to skeletal muscle is increased to enable greater speed, agility, and endurance. Increased blood flow to the brain and sense organs heightens perception and reduces reaction time.

Active defense response is energetically costly. The impact of stress still remains to be sufficiently evaluated. Anderson (1995) held that "while all impacts on animals cannot be documented, it is clear that loss of body reserves has negative effects on the individuals concerned. When combined with other factors such as a stressful winter, the animals could die or fail to reproduce. In such cases, populations would decline."

Another avoidance response is the passive defense response in which an animal reduces movement and breathing sounds; however total implications with respect to energetics are not fully understood (Jacobsen 1979; Sluckin 1979). "The passive defense response involves profound physiological adjustments. Some of the major physiological adjustments for animals exhibiting the response include inhibition of activity, decreased blood flow to skeletal muscle, reduced blood flow to digestive system, reduced heart and respiratory rate, and a reduction of body temperature" (Gabrielsen and Smith 1995). An example of the passive defense response would be a deer fawn that was bedded down and motionless when approached by a human. Depending on the circumstances, animals may exhibit both the passive and active defense responses; for example, an incubating hen mallard may remain motionless when approached by a human (passive defense response) but will switch to a flight response (active defense response) once the disturbance becomes an immediate threat to life.

Bowles (1995) suggest that many species of wildlife depend on meaningful sound to avoid dangers and will differentiate meaningful sounds from background noise. She gives the example that noisy vehicles will be detectable at ranges of several kilometers in a typical, quiet wilderness environment. If animals respond as soon as they detect a sound, loud sounds such as noisy vehicles could affect them at much greater ranges than human speech. However, if they are habituated to vehicle noise at levels that are not aversive, humans laughing and yelling can arouse responses at greater ranges than vehicles. A weighted day-night sound level (DNL) of 70 dB(A) is used by most agencies as an upper limit for long-term exposure in air, and the equivalent continuous sound level (L_{eq}) values of 80 to 100 dB(A) for short exposures of a few minutes to a few hours (Bowles 1995). Wildlife response to noise is often difficult to assess because it may be confounded by response to visual stimulus (Busnel 1978).

Knight and Cole (1991) suggest that sound may elicit a much milder response from wildlife if animals are visually buffered from the disturbance (Singer 1978). Bowles (1995) recommends the following measures to limit noise effects in situations where noisy human activities and animals must coexist: (1) keep noisy sources from approaching animals on a directed course; (2) make noise sources predictable, for example by limiting vehicles to roadways, boatways, and specified flight paths at predictable times; (3) stop approaches if animals react with avoidance, defensive behaviors, or aggression; (4) gradually habituate animals to noise; (5) alter noise to make it less attractive.

Habituation is defined as "a form of learning in which individuals stop responding to stimuli that carry no reinforcing consequences for the individuals that are exposed to them" (Alcock 1993). Gabrielsen and Smith (1995) suggest that mammals and birds nesting close to human settlements seem to have built up a higher tolerance threshold toward vehicles and human presence. Gabrielsen and Smith (1995) suggest that the magnitude of the response of wildlife to disturbance depends in part on the "distance, the movement pattern of the disturbance, and the animal's access to cover. Most animals seem to tolerate disturbance better in woodland than in open terrain. They also seem to have a greater defense response to humans moving unpredictably in the terrain than to humans following a distinct path. To reduce the effects of human disturbance, permanent paths should be used or traffic should be restricted or reduced to certain times of the year in sensitive areas"(Gabrielsen and Smith 1995).

Wildlife may be attracted to human presence. Knight and Temple (1995) noted that wildlife may be converted to "beggars" lured by handouts. This attraction is reinforced by the reward of food for animals such as gulls or magpies. This situation can potentially harm both humans and wildlife as in the case flies, rats and mice being attracted to solid waste receptacles and serving as vectors for the spread of disease (Knight and Temple 1995) or ducks congregating at artificial feeding sites and transmitting avian diseases. Busnel (1978) cited instances where human-induced noise had an attractant effect on some species, such as engine noise to mosquitoes. Wildlife attracted to roads (e.g. raptors feeding on road kills) could be hit by fast moving vehicles (Rosen and Lowe 1994).

Wildlife principles are established when numerous studies repeat consistent results. In the absence of site specific information, published scientific data can provide insights to and may be useful in predicting wildlife responses in other locations when careful consideration is given to site specific biological information, potential confounding factors and professional knowledge. However, Knight and Cole (1991) noted in their review of wildlife responses to human activities that considerable intra and inter-specific variation existed.

Wildlife Dependent Recreational Uses

Waterfowl Hunting

Direct effects of hunting on waterfowl are mortality, wounding and disturbance. Waterfowl abundance and harvest is monitored and managed by the U.S. Fish and Wildlife Service (Service), the Canadian Wildlife Service, and state wildlife agencies which annually collect waterfowl data (e.g., May breeding population surveys, July production surveys, midwinter counts), habitat data and hunter harvest data to estimate waterfowl production and abundance (U.S. Fish and Wildlife Service 1998a, b). Based on annual production and fall flight forecasts, waterfowl hunting regulations are set annually. Braun et al. (1978) concluded that Federal and state regulations on season length, bag limits, and methods of taking were more than adequate to maintain waterfowl resources.

"In 1995, the U.S. Fish and Wildlife Service embraced the concept of adaptive resource management for regulating duck harvests in the United States. The adaptive approach explicitly recognizes that the consequences of hunting regulations cannot be predicted with certainty, and provides a framework for making objective decisions in the face of that uncertainty. Moreover, adaptive harvest management relies on the iterative cycle of monitoring, assessment, and decision making to clarify relationships among hunting regulations, harvest, and waterfowl abundance"(U.S. Fish and Wildlife Service 1998c). A critical need for successful implementation of the adaptive harvest management is a set of regulatory alternatives that remain fixed for an extended period. When adaptive harvest management was first implemented in 1995, three regulatory alternatives characterized as liberal, moderate, and restrictive were defined based on recent regulatory experience. To date, adaptive harvest management has focused primarily on midcontinent mallards, but progress is being made to extend the process to account for breeding mallards on a continental basis (U.S. Fish and Wildlife Service 1998c).

Although waterfowl harvest is managed with Federal hunting regulations at the flyway population level, hunting programs on National Wildlife Refuges must be compatible with the mission of the National Wildlife Refuge System and refuge purposes and should be designed to reduce disturbance to waterfowl and other wildlife. In 1989, 202 of 478 (42 percent) refuge units (including National Wildlife Refuges, waterfowl production areas, and wetland management areas) surveyed allowed waterfowl hunting (U.S. Fish and Wildlife Service 1990). In all cases where the Service had legal authority to control hunting (n=197), the waterfowl hunting program was considered compatible. However, on 32 of 202 refuge units (16 percent), waterfowl hunting was considered harmful as defined as "the net result of the activity is that it adversely affects the ability of the refuge manager to conserve or manage in accordance with the refuge/wetland management goals and objectives" (U.S. Fish and Wildlife Service 1990).

Some refuges do not permit waterfowl hunting. For example, Blackwater NWR "is managed in support of broad regional conservation goals, as non-hunted resting and feeding grounds for migratory birds. The refuge is surrounded by private and other public lands that are extensively hunted within the region. To manage this refuge to allow waterfowl hunting may be inconsistent with principles of sound fish and wildlife management and, in such circumstances may not be permitted"on National Wildlife Refuges (House of Representatives Report 105-106).

The response of waterfowl to human disturbance is related to the experience of waterfowl with hunters and hunting (Morton 1995). Waterfowl in city parks often feed from human hands; while waterfowl that experience hunting activities are much more wary of human activities. Wintering brant flushed at distances greater than 500 meters on tidal flats that were frequented by hunters, but could be approached within 150 meters on unhunted flats (Owens 1977). Likewise, American crows habituated to humans in an area of high human density and low persecution (i.e., cities), whereas rural crows which were actively persecuted showed strong avoidance behavior (Knight et al. 1987).

Bélanger and Bédard (1995) conclude that disturbance caused by hunting can (1) modify the distribution and use of various habitats by birds (Owens 1977; White-Robinson 1982, Madsen 1985); (2) affect their activity budget and reduce their foraging time and consequently their ability to store fat reserves necessary both for migration and breeding (Raveling 1979; Thomas 1983); and finally, (3) disrupt pair and family bonds and contribute to increased hunting mortality (Bartelt 1987). Knight and Cole (1995) concluded that hunting can alter behavior, population structure, and distribution patterns of wildlife. Hunting can also effect the diversity and number of birds using a site (Madsen 1995). In Denmark, Madsen (1995) reported that the avian diversity changed from predominantly mute swan and mallard to a more even distribution of a greater number of species when a sanctuary was established; hence, biodiversity in an area increased with the elimination of hunting.

Distribution and Energetics

There appears to be an inverse relationship between the numbers of birds using as area and hunting intensity (Reichholf 1973, Arctander et al. 1984, Madsen et al. 1992 as cited by Fox and Madsen 1997). In Connecticut, Cronan (1957) found that lesser scaup foraged less in areas that were heavily hunted. In California, Heitmeyer and Raveling (1988) reported that the numbers of northern pintails on Sacramento NWR increased the first week following the opening of hunting season and remained high until hunting seasons ended in early January. Pintails used private duck club wetlands prior to and immediately following, but generally not during, the waterfowl hunting season. Pintail, wigeon, and shoveler greatly reduced their use of the hunt area on Sacramento NWR during hunting seasons. Following the close of hunting seasons, ducks generally increased their use of the hunt area, however, use was lower than before hunting season began. Paulus (1984) similarly suggested that wintering gadwalls responded to hunting activity in wetlands outside Rockefeller state refuge by using refuge impoundments that were closed to hunting. During fall migration on Keokuk Pool, Mississippi River, Thompson (1973) reported that waterfowl use was inversely related to human disturbance (hunting, fishing, and boating); sections of the river with greater human disturbance had lower use by ducks. Bias et al. (1997) suggested that in general waterfowl use decreases as frequency of human disturbance (i.e., hunting and management activities) increases.

In Wisconsin, Zicus (1981) concluded that hunting pressure caused Canada goose families feeding outside the refuge area to change fields, but subflock composition and roosting locations on the refuge were unchanged. Bélanger and Bédard (1995) found that flock size of migrating snow geese in Quebec significantly decreased with increasing disturbance rates during the hunting season. At low rates of disturbance, no change was noted in flock size the next day but when the disturbance rate reached or exceeded 2 per hour, the flock size decreased by about 50 percent (approximately 4,000 birds), suggesting that 50 percent of the flock dispersed to other areas as a result of hunting disturbance. In Denmark, Madsen (1988 as cited by Knight and Cole 1995) noted that there where six times more geese present when no shooting occurred the previous afternoon compared to when shooting had occurred the day prior. Newton and Campbell (1973) noted similar response by hunted geese in Scotland; geese usually avoided feeding in fields where shooting had occurred. Henry (1980) reported that densities of brant in California were lower in areas with human activity than in undisturbed areas. In response to open-water scull-boat hunting, brant left the bay and flew to the ocean where food was scarce.

To minimize exposure to hunters and hunting activity, waterfowl may shift their use of habitats spatially and/or temporally. In Denmark, Madsen (1995) experimentally tested disturbance effects of hunting by establishing two experimental sanctuaries that varied in location annually. In both sanctuary areas, waterbird numbers increased, most strongly in hunted species (3 to 40 fold increase), with highest densities in the sanctuary areas, irrespective of where these sanctuaries were sited. At Sacramento NWR, California, diurnal densities of northern pintails were significantly different among hunting units, units adjacent to hunting units, units adjacent to auto tour route, and units isolated from disturbance (Wolder 1993). Prior to the opening of the hunting season, pintail used units in proportion to the available seasonal wetlands, indicating no preference to particular disturbance category areas. During the hunting season, 50 to 60 percent of the pintails on the refuge were located on the isolated units that contained 26 to 28 percent of the refuge seasonal wetlands, suggesting a strong preference by waterfowl for areas with little human activity. Units along the auto tour route and adjacent to hunting units maintained pintails at similar proportions to seasonal wetland availability. Three to 16 percent of the pintails on the refuge were located on hunted units (36 to 40 percent of the available seasonal wetland habitat) during non-hunt days (four days per week) and were almost entirely absent on days when hunting was taking place, indicating an avoidance of the hunted areas during the hunting season. Nocturnal pintail use was not measured, but there were indications that duck use increased on hunt units during the night (M. Wolder, Wildlife Biologist, U.S. Fish and Wildlife Service, pers. comm. 1999). Wolder (1993) suggested that human disturbance was a major factor in the distribution of pintails on the Sacramento NWR and should be considered when making habitat management decisions.

Bélanger and Bédard (1995) stated that"nocturnal feeding in waterfowl is a common phenomenon often associated with heavy hunting pressure (Owen 1970; Owens 1977; Burton and Hudson 1978)." Heitmeyer and Raveling (1988) observed that the occurrence of night feeding flights to private lands corresponded with the opening of hunting seasons. Within two weeks following the opening of waterfowl hunting season, more than 90 percent of all dabbling ducks on the Sacramento NWR were making flights off the refuge at dusk and feeding primarily in rice fields. Following the close of hunting seasons, ducks continued to make night feeding flights, used densely vegetated habitats, and reduced

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diurnal time spent feeding for two to four weeks. Thereafter, habitat use and activity patterns resembled those prior to the opening of hunting seasons in a given year. They suggested that night feeding flights in the Sacramento Valley seem primarily induced by disturbance and the increased risk of mortality during the hunting seasons. Morton et al. (1989a, 1989b) suggested that disturbance levels (primarily hunting activity) outside Chincoteague NWR were high enough to force wintering black ducks into a pattern of nocturnal feeding within surrounding saltmarsh and diurnal resting within refuge impoundments. During fall migration on Keokuk Pool, Mississippi River, Thornburg (1973) described the local movements of migrating diving ducks as a morning flight at dawn from highly disturbed (hunter, fishing, and boating activity) sections of the Mississippi River to less disturbed sections where birds loafed throughout the day. During this time, 90 percent of waterfowl were located on 28 percent of the study area in areas with lower abundance of invertebrates. Diving ducks returned to preferred feeding areas at night and were distributed in correlation with the greatest abundance of benthic organisms (Thornburg 1973). Movements and distribution of diving ducks apparently were influenced by high intensity human disturbance, primarily hunting activity, and food availability. Girard (1941) and Bellrose (1944) reported that disturbances due primarily to hunting caused rapid alteration of waterfowl flight and feeding routines (as cited by Thornburg 1973). Hunted geese in Denmark avoided traditional feeding sites and fed more during the night (Madsen 1988 as cited by Knight and Cole 1995).

Jorde and Owen (1988) reported that "for many species, foraging is the dominant nighttime activity, consuming as much as 90 percent of the time for green-winged teal (Ana crecca) in France (Tamisier 1974)." They suggested that numerous variables influence nocturnal activity including species, season, geographic location, weather, food resources, lunar and tidal cycles, physiological condition of the bird, and activity of predators, including humans.

Baldassarre et al. (1988) noted that "only a few TA (timing activity) studies of wintering waterfowl have included extensive nocturnal data (Tamisier 1972, Paulus 1984a, 1984b). This lack of data is significant because TA studies based only on diurnal data cannot reflect diel patterns. For example, it can be energetically advantageous for waterfowl to rest and sunbathe on cold winter days and to feed at night, but the daily inactivity might be misinterpreted unless nocturnal data were collected." Similarly, Jorde and Owen (1988) suggested that microclimates warmed by the sun most likely influence waterfowl to spend more time in energy conserving behaviors during the day and to be more active at night when heat generated by muscular activity and digestion offsets some of the costs of thermoregulation (Jorde et al. 1984). However, Heitmeyer and Raveling (1988) suggest that "in locations where good quality and quantity habitats and foods are available, waterfowl typically do not feed at night during winter (e.g. Winner 1959, Raveling et al. 1972, Jorde et al. 1983, Baldassarre and Bolen 1984, Heitmeyer 1985)"

Hunting limits access of waterfowl to food resources. Heitmeyer and Raveling (1988) found that female northern pintails, American widgeon and northern shovelers decreased time spent feeding on days when hunting occurred on public shooting areas compared to non-hunt days. Madsen (1988 as cited by Dahlgren and Korschgen 1992) suggested that hunting on the coastal wetlands of Denmark influenced waterfowl movements and caused birds to leave the area prematurely. In 1985, Madsen considered the duck hunting pressure to be moderate, whereas in 1986, it intensified, displacing ducks and brant to a non-hunting area. The non-hunting area was soon depleted of resources, and most of the waterfowl left the area earlier than in 1985, even though food was still available in the hunting area. Subsequently, hunting disturbance effects were experimentally tested by the establishment of two sanctuaries (Madsen 1995). Over a five-year period, these became two of the most important staging areas for coastal waterfowl. Numbers of dabbling ducks and geese increased 4 to 20 fold within the sanctuary and these species prolonged their staging periods up to several months compared to baseline periods. Madsen concluded that waterfowl left staging areas due to human disturbance even when food resources were still plentiful and the creation of these sanctuaries should result in improved resource use along the migration routes. He suggested that if population sizes are limited by winter resources, reserve establishment would lead to improved winter survival.

Likewise, Kahl 1991 suggested that reduced forage access may decrease survival of canvasbacks by causing birds to remain on a staging site longer and forage under suboptimal conditions, or by causing birds to migrate in shorter flights with more frequent stops (Korschgen et al. 1988, Serie and Sharp 1989). Kahl concluded that the frequency of disturbance (boating associated with hunting and fishing) and limited access to food resources documented in his study in Wisconsin suggested that human disturbance is an important management concern. Henry (1980) concluded that denying brants an undisturbed feeding place during the day could result in a loss of energy and lowering of body weight when the birds need to prepare for northward migration and breeding.

Hunting activity may increase movements and reduce time for foraging, thereby increasing energy use (Fredrickson and Drobney 1979). Disturbance due to hunting has reportedly reduced time spent in feeding and/or resting activities for several species of wintering or migrating waterfowl (Cronan 1957: lesser scaup; Paulus 1984a: gadwall; Thompson 1973, Thornburg 1973, Korschgen et al. 1985: canvasback; Morton et al. 1989ab: black duck; Bélanger and Bédard 1995: snow geese). Bias et al. (1997) provided an example of how extraneous activities that increase an animal's flight time can have consequences on body condition. "For example, a mallard that weighs 2.5 pounds would require three days of foraging to replenish fat reserves following an eight hour flight if caloric intake were high (480 kcal/day), similar to that provided in high quality habitat types. However, if caloric intake was less (only 390 kcal/day), as provided among poor quality habitat types, then the mallard would need eight days to replenish the same reserves. With additional flight time from disturbance, foraging time is correspondingly decreased and prolongs the time necessary to meet nutritional needs. This becomes increasingly important as weather conditions get colder, requiring greater food intake to maintain body condition and weight" (Bias et al. 1997 after Fredrickson and Reid 1988).

At Chincoteague NWR, Morton et al. (1989a) found that wintering black ducks experienced reduced energy intake while doubling energy expenditure by increasing the time spent in locomotion in response to disturbance. Black ducks consumed 10.4 times more energy in flight than at rest, and 1.8 times more energy in alert behavior or swimming than at rest (Wooley and Owen 1978 as cited by Morton 1995). Morton et al. (1989a) suggested that human disturbance of wintering black ducks impaired their physiological condition, thereby reducing winter survival and/or nutrient reserves carried to the breeding grounds.

Bélanger and Bédard (1995) found that hunting and transportation (planes, helicopters, ferry boat, motorboats) related activities caused the greatest loss of snow geese feeding time in fall ($\geq$ 15 min/disturbance) whereas nonhunting activities (bird watchers and photographers) caused less than 9.1 min/disturbance. Modeling of snow geese energetics at Arctic NWR suggested that reduced feeding time and energy intake have greater effects on daily fat gain than increased energy expenditure due to flight (Brackney 1987 as cited by Morton 1995).
Bélanger and Bédard (1995) stated that"an increase in night feeding as a compensatory mechanism for loss of daytime feeding opportunities due to disturbance has been suggested (Thornburg 1973, Pedroli 1982; Tuite et al. 1983), but quantitative assessments have not been performed." In Louisiana, Paulus (1984a) suggested that increased foraging time by gadwalls was insufficient to counterbalance disturbance factors, reduced forage quality, and adverse weather conditions. Paulus reported that time spent feeding increased from 44 percent in October to 77 percent in April and noted that gadwalls spent significantly more time feeding during the night than during the day. Peak feeding activity during day

and night usually occurred when daily temperatures were lowest and costs of thermoregulation were greatest. Feeding activity also varied depending upon habitats and foods used. Gadwalls were rarely observed leaving feeding areas during day or night except when disturbed or during the hunting season. Since gadwalls spent most of their time feeding, Paulus recommended that the primary goal of management should be to ensure that preferred feeding habitats are preserved.
Bélanger and Bédard (1995) quantitatively estimated the energetic cost of two major responses to disturbances displayed by greater snow geese- Response A: birds flew away but promptly returned to the foraging site and resumed feeding, and Response B: birds flew away, left the foraging site for a roost site, and interrupted feeding. They estimated that neither response allowed snow geese to balance their daytime energy budget. At high disturbance rates (greater than two per hour), an increase in night feeding as a behavioral compensatory mechanism could not counterbalance energy lost during the day. Likewise, geese could not compensate for a loss in feeding time by increasing their daily foraging behavior to maximize food intake during undisturbed periods. Bélanger and Bédard reported that two disturbances per hour may cause an energy deficit that no behavioral compensatory mechanism, including night feeding, can counterbalance. Bélanger and Bédard (1995) suggested mitigation with spatial or temporal buffer zones.

Frequency of Disturbance

Disturbance effects on waterfowl may be managed temporally. In general bird use decreases as frequency of disturbance increases (Bias et al. 1997). Bias et al. (1997) suggested that generally, the less birds are disturbed on a particular area prior to hunting, the more quickly and more often they will return. "As much as possible, managers of private hunting areas should strive for establishing a "tradition of use" for waterfowl, whereby birds become accustomed to using an area from day-to-day and year-to-year."

Fox and Madsen (1997) suggested that intermittent hunting is not an effective means of minimizing disturbance; but where implemented, rest periods between hunting events should be considered in weeks rather than days. At Sacramento NWR with an intermittent hunting program of three hunt days per week, pintail densities were lower on hunt areas during non-hunt days than non-hunt areas. On non-hunt days, Wolder (1993) observed that the hunted units which comprised of 36 to 40 percent of the wetlands, held 3 to 16 percent of the northern pintails on the refuge. On a Swedish lake, the effect of intermittent shooting was tested, with shooting being allowed one day per week. Duck numbers increased during the six days of respite, but took more than a week to recover to the levels observed when shooting was completely banned (Anderson 1977 as cited by Fox and Madsen 1997). In Germany, several studies reported a range from a few days to approximately three weeks for waterbird numbers to recover to levels prior to disturbance (Jettka 1986, Ziegler and Hanke 1988, Gerhard 1994 as cited by Fox and Madsen 1997).

To give waterfowl opportunity to forage undisturbed during the day, shooting of geese is banned after 10:00 a.m. in the Netherlands and Denmark and after 11:00 a.m. in Sweden and Norway (Fox and Madsen 1997). However, the effects of this practice on bird behavior and site use are poorly described in the literature. From 1990 to 1993, a study of the effects of half-day hunting (1:00 pm closure) for Canada geese at Swan Lake NWR, Missouri, was conducted (Humburg et al.1995, unpub. report). The objective of a half-day hunting restriction was to improve goose use of food resources within hunting zones, yet maintain or increase hunting success. Preliminary results suggests that goose hunters in half-day blinds were as successful as those hunting all-day blinds. Similarly, results of a 1987 survey of goose hunters at Swan Lake NWR indicated that approximately 2/3 of the attempts for geese (64.9 percent), shots fired (64.3 percent), and birds bagged (67.7 percent) occurred prior to 10:00 am.

However, 61 percent of hunters surveyed preferred no change in closure time, while 21 percent of hunters preferred half-day hunting for the first few weeks of the season and 16.2 percent preferred half-day hunting during the entire season. Humburg et al. (1995, unpub. report) suggested that an early closure may not be acceptable to hunters that have to travel long distances to Swan Lake NWR and wish to take full advantage of the trip. Hunting opportunities would also be reduced later in the season as cold weather limits goose movement to late afternoon.

Humburg et al. (1995) stated that duck hunting success in half-day hunted areas is at least as high as success in areas hunted for full days on Missouri wetland areas. Likewise, results from the U.S. Fish and Wildlife Service Parts Collection Survey (as cited by Humburg et al. 1995), 1985-86, indicated that about 70 percent of the mallard harvest and 77 percent of the total duck harvest in the Central Flyway occurred prior to noon. Carney (unpub. data as cited by Humburg et al. 1995) reported in 1975 that approximately 75 percent of the nationwide harvest occurred before mid-day. Reynolds (1984 as cited by Humburg et al. 1995) showed that only about 25 percent of Maryland hunters hunted more than 5 ½ hours after sunrise. D. Graber (Missouri Dept. of Conservation, pers. comm. 1998) has observed ducks returning to foraging areas in the afternoon in apparent response to half-day hunting. Likewise, Havera (1992) recommended hunting until noon on Keokuk Pool, Mississippi River as one of several solutions to reduce waterfowl disturbance.

In the fall of 1975, Tule Lake NWR and Lower Klamath NWR, California, initiated a 1:00 pm hunting closure, seven days a week. "Geese, in particular, reacted favorably to the afternoon closure. They commonly moved into the hunting areas in large numbers late in the day" (U.S. Fish and Wildlife Service 1975 Annual Narrative). Average hunter success (number of ducks and geese per hunter) was similar during the six hunting seasons prior to the 1:00 pm closure and the six hunting seasons following the initiation of the 1:00 pm closure, 1.46 and 1.44 birds per hunter, respectively, at Tule Lake NWR and 1.45 and 1.95 birds per hunter, respectively, at Lower Klamath NWR (U.S. Fish and Wildlife Service, Klamath NWR Complex, unpublished data and Annual Narratives). Currently, D. Mauser (Wildlife Biologist, U.S. Fish and Wildlife Service, pers. comm. 1999) has observed that waterfowl use of hunt areas increases after 1:00 p.m at Tule Lake NWR and Lower Klamath NWR during the hunting season.

Hunter Density and Other Management Considerations

Waterfowl respond to low hunter density and show differential response by species. In Denmark, over 6.6 mile^2 (17 km^2) of costal shallow waters, greylag goose numbers started to decline when any hunters were present, dabbling duck numbers declined when more than three hunters were present in the area, and mute swan numbers declined when the number of hunters exceeded six (Madsen et al. 1992 as cited by Fox and Madsen 1997). Hunters were shooting from reed beds, sand bars or from anchored shooting punts. In Texas, Mabie (1985) concluded that at low hunter and fishermen densities ranging from 1 person per 119 to 875 acres on Saturdays and 1 person per 1,312 to 5,250 acres on weekdays, human activity was sufficient enough to influence waterfowl distribution. Dabblers were the most affected waterfowl and stayed in certain areas of the marsh throughout the day as a result of hunter activity (hunting from blinds and transported with outboard motorboats and airboats). Along the Danish Wadden Sea foreshore, Frikke and Laursen (1994 as cited by Fox and Madsen 1997) found that dabbling duck use (measured by dropping density) was inversely related to hunting activity, both expressed as hunter density and number of shots fired in the evening. Even at low hunting activity, i.e. on average 1 hunter per 0.62 mile (1 km) of coast, or less than 50 shots per hour during the evening, duck use was reduced to virtually nil.

Humburg (1989) identified additional special hunting regulations implemented by various states to both protect waterfowl resources and improve hunting quality. "An example in the Swan Lake Zone, Missouri is the 10-shell limit, which was implemented to reduce crippling rates of geese. Portions of most Missouri wetland areas have been designated as inviolate refuges to ensure that undisturbed areas are available during the hunting season. Hunter numbers are regulated and blinds are distributed or visually isolated to ensure safe hunting conditions and to reduce disturbance from other hunters." Likewise, Sacramento NWR has a 25-shell limit and hunter numbers are regulated in both free-roam and designated blind hunt areas at densities of 15 acres per hunter and 40 acres per blind, respectively.

"The very limited information available indicates that mobile hunting techniques generally cause greater disturbance to waterbirds than do hunting techniques that operate from a fixed point. Gaining access to fixed hunting points may also be an important source of disturbance, and this factor should be considered in concert with other general public access arrangements" (Fox and Madsen 1997). Havera et al. (1992) identified public awareness of the problem, increased law enforcement to reduce intentional disturbances, regulations restricting boating to a specified distance from rafting waterfowl, and hunting only until noon as other possibilities for reducing disturbance of waterfowl on Keokuk Pool. They concluded that a minimum buffer zone of 490.5 yards (450 m) should protect rafting diving ducks from boating activity. Nevertheless, Havera et al. (1992) concluded that, on Keokuk Pool and elsewhere in similar situations, a sanctuary would likely be the most effective means of decreasing disturbance to diving ducks.

Heitmeyer and Raveling (1988) reported that waterfowl use of densely vegetated wetlands with more than 40 percent cover of cattails and tules increased during the hunting season. Bias et al. (1997) suggested that wetlands with a least 40 percent cover of tall emergent vegetation such as tules or cattails, help block visual or noise stimuli from disturbance sources, such as vehicles, shooting, and equipment, and that many waterfowl will select these heavily vegetated areas particularly during hunting season.

Provision of Sanctuaries

Havera et al. (1992) said that Dahlgren (1988), "in his comprehensive literature review of human disturbances to migrating and wintering waterfowl, noted that refuge (i.e. sanctuary) was mentioned as the most common solution to disturbance problems". Heitmeyer and Raveling (1988) reported that during the hunting season, most waterfowl present in the Sacramento Valley used NWR's and state or private sanctuaries during the day and private rice fields at night. They suggested that resources on private wetlands seemed most important to ducks before and after hunting seasons; resources on sanctuaries of public lands were most valuable to waterfowl during the hunting seasons; and resources on public hunting areas were most important prior to hunting seasons.

Based on a review of the effects of hunting, Fox and Madsen (1997) provided recommendations to mitigate disturbance effects on wildlife. These include removal of hunting in "refuges" (i.e. sanctuaries), as well as spatial and temporal regulation of hunting activity in reserve areas outside hunting-free areas. Disturbance-free sanctuary design should take into account ecological requirements and the functional units required to meet all daily activities, especially primary feeding and roosting areas used by waterbirds. Sanctuary size and shape must ensure birds are free from the effects of external disturbance. Fox and Madsen (1997) also recommended sanctuaries with regular shape, maximum practicable size, and as a minimum should have a diameter of 3 times the escape flight distance of the most sensitive species present. Flock size also affects flush distance; larger flocks tend to react at greater distances (Madsen 1985 as cited by Fox and Madsen 1997). Hence, larger sanctuary blocks may actually require greater buffer zones to maximize their effectiveness.

In a technical guidance publication for private land managers in California's Central Valley, Bias et al. (1997) suggested that "creating sanctuary areas or areas with minimal human disturbance, among a diversity of habitat types that provide adequate food and cover resources is probably the most effective management tool to encourage waterfowl use over time. At least 50 acres would be the minimum size for a functional sanctuary. Larger properties could more easily accommodate a large functional sanctuary.... Sanctuaries provide core use areas that enhance the use of adjacent areas by holding more birds closer to a hunting area". In Wisconsin, Kahl (1991) recommended, based on estimated canvasback flight distances from boats at Lake Poygan, that sanctuaries should be at least 0.58 to 0.77 square mile (1.5 to 2.0 km^2) and encompass as much of a feeding area as feasible.

Impacts on Non-hunted Wildlife Species

We found very few studies that discussed disturbance associated with waterfowl hunting and other wildlife species. Mabie et al. (1989) mimicked hunter activities (airboats and outboard motorboats) at an average distance of 600 meters to cranes and observed no significant increase in alert behavior. However, Mabie et al. concluded that direct approach of airboats caused a detectable change in alert behavior among four family groups of whooping cranes. Braun et al. (1978) recommended where endangered species are involved, such as whooping cranes and Mexican ducks, a reevaluation in the hunting of "look-alike" species is advisable and discontinuation of "look-alike" species hunting may be appropriate.

Fishing

Fishing activities may influence the composition of bird communities (Tydeman 1977), as well as distribution, abundance, and productivity of waterbirds (Bell and Austin 1985, Bordignon 1985, Edwards and Bell 1985, Cooke 1987, Bouffard 1982). In 1989, 268 of 478 (56 percent) refuge units allowed recreational fishing (U.S. Fish and Wildlife Service 1990). In seven cases (3 percent) where the Service had legal authority to control fishing (n=220), the fishing program was considered incompatible and on 34 refuge units (13 percent) recreational fishing was considered harmful (U.S. Fish and Wildlife Service 1990).

In Great Britain, Bell and Austin (1985) demonstrated a strong correlation between wintering waterfowl and habitat availability prior to the start of the fishing season; however, during the fishing season this relationship was not detected. Bell and Austin suggested that anglers displaced waterfowl from their preferred feeding and roosting areas and caused wigeon, green-winged teal, pochard and mallard to depart from the reservoir prematurely. Likewise, Cooke (1987) documented that anglers on the bank and in boats often fished the shallow, sheltered bays and creeks that birds favor and negatively impacted distribution and abundance of waterfowl, grebes and Eurasian coots.

Activities associated with angling have resulted in reduced waterfowl production in some areas (Keith 1961, Barngrover 1974, Bouffard 1982). Anderson (1995) stated that "during the waterfowl breeding season, anglers contributed to a serious decline in breeding waterfowl. One study in Germany revealed a 90 percent decrease over ten years. The investigator found that a single angler can prevent ducks from establishing territories or selecting nest sites when the area of open water is less than one hectare. Disturbance was less of a problem on larger waters. Intensive angling reduced the number of waterfowl nests by 80 percent, and the remaining nests were found only in areas inaccessible to anglers" (Reichholf 1976). Cooke (as cited by Liddle and Scorgie 1980) suggested that anglers create an area around them within which birds will not venture. Thus, an angler sitting on the shore can effectively exclude birds from his immediate vicinity. Satchell (1976 as cited by Liddle and Scorgie 1980) suggested that breeding failure is often associated with increased predation when the parent birds are kept away from the nest by disturbance.

At Seney NWR, Michigan, waterfowl use of wetland area open to recreational fishing was reportedly low; however, in the subsequent two years when the area was closed to fishing, a marked increase in number of broods and adults was observed (Beard 1953). Similarly at Kirch Wildlife Management Area, Nevada, Barngrover (1974) reported that recreational fishing conflicted with waterfowl production and recommended modifications to the fishing regulations to assure maximum waterfowl production. In Washington, poor breeding success of Canada geese was also attributed to anglers and other shoreline human activity (Yocom et al. 1956).

Other effects from recreational fishing include waterfowl fatalities resulting from entanglement with trot-lines and trammel nets (Thompson 1969) and degradation of wildlife habitat (Liddle and Scorgie 1980). Shoreline activities such as fishing, hunting, and hiking reportedly result in trampling of vegetation, as well as deposition of sewage and other chemicals (Liddle and Scorgie 1980). Rees (1978 as cited by Liddle and Scorgie 1980) noted that paths made by fishermen and waterfowl hunters were usually between 30 and 45 cm wide, and were typically parallel to the shore at the junction of two plant communities. The author observed that on little-used pathways the dominant emergent species were still present. They were replaced on medium-used pathways by harder wearing species and the heavily-used pathways largely consisted of bare mud with occasional invading species.

Knight et al. (1991) experimentally examined the responses of an avian scavenging guild (bald eagles, common ravens, and American crows) to anglers in Washington and found that anglers did influence the numbers, behavior and diurnal distribution of avian scavengers present at sites during fishing days when compared with nonfishing days. Anglers, however, had little effect on the presence or absence of individuals species; rather anglers' presence was associated with fewer avian scavengers actually feeding on salmon carcasses. Knight et al. concluded that current management approaches to minimize the effects of recreational disturbances on wildlife appeared adequate for the avian scavenging guild and included restricting human access to certain areas, buffer zones, and a two-day-a-week fishery on the Toutle River.

Stocking Exotic Fish

Bouffard and Hanson (1997) suggested that introductions of exotic fish in many wetland habitats alter native aquatic communities, influence nutrient dynamics and productivity, and modify natural food webs. Fish may compete with waterfowl for invertebrate food items (both groups prefer large-bodied invertebrates as prey), reducing waterfowl productivity and wetland biodiversity. Aquatic systems are being degraded, and populations of endemic aquatic species are declining (Wilcove et al. 1992). For example, of native North American species, 34 percent of fish, 65 percent of crayfish, and 73 percent of unionid mussels are at risk (Wilcove et al. 1992 as cited by Bouffard and Hanson 1997). Observational and experimental studies have demonstrated that zooplanktivorous and benthivorous fishes can dramatically restructure wetland food webs. These direct and indirect effects have the potential to shift wetlands from macrophyte-dominated to phytoplankton-dominated communities, limiting waterfowl productivity by reducing invertebrate and macrophyte forage bases.

Although acknowledging a high and increasing demand for recreational fishing, Bouffard and Hanson (1997) recommended that (1) introduction of nonnative fish into waterfowl marshes be discontinued; (2) stocking of native fish to augment existing fish populations be discontinued, except for recovery actions for rare and endangered species, and for improvement of the prey base for piscivorous wildlife species;

and (3) where feasible, introduced fish, including North American species introduced into nonnative habitats, be eliminated from important waterfowl marshes. Bouffard and Hanson suggested that naturally existing populations of native fish may still support recreational and commercial fisheries and should be allowed on NWRs if compatible with wildlife.

Considerations to Reduce Disturbance

In areas of multiple recreational uses and wildlife objectives, numerous authors recommended designating confined fishing areas to reduce disturbance or temporal restrictions of fishing during critical waterfowl wintering and breeding periods (Yocom et al. 1956, Johnson 1964, Braun et al. 1978, Mathews 1982, Edwards and Bell 1987). Braun et al. (1978) reported that prime nesting areas on many refuges are closed to fishing until about July 1 to 15 when most nesting has been completed. Braun et al. suggested that, especially in northern areas, fishing should be delayed until August 1 to protect late nesting species and their broods. Many southern refuges prohibit fishing during the winter to provide sanctuary for wintering waterfowl (Braun et al. 1978).

Jahn and Hunt (1964) reported that increases in recreational activity by anglers, boaters, and shoreline activity appeared to discourage waterfowl from using otherwise suitable habitat. In a review of disturbance impacts of angling on wildlife in England, Edwards and Bell (1987) documented frequent disturbing effects of angling and boating and recommended that sanctuaries be expanded during the critical wintering and breeding periods. Likewise in the United States, Johnson (1964) concluded that if waterfowl used heavily fished waters for breeding, resting, or feeding, they will be disturbed often by anglers who use boats or fish from the banks. He recommended zoning certain water areas for use by waterfowl or by restricting fishing during the season when waterfowl are nesting and rearing broods.

Wildlife Observation

Once considered "nonconsumptive", it is now recognized that wildlife observation and wildlife photography can negatively impact wildlife by altering wildlife behavior, reproduction, distribution and habitat (Purdy et al. 1987, Knight and Cole 1995). Wildlife observers actively seek out wildlife which may result in encounters that are more frequent and longer in duration than non-wildlife dependent recreation. "Nature viewing by its very definition, has great potential to negatively affect wildlife. Avid wildlife viewers intentionally seek out rare or spectacular species. Some types of wildlife viewers have a reputation for striving for the most viewing opportunities in the least amount of time (e.g., bird listing). Because these activities may occur during sensitive times of the year (e.g., nesting), and because they often involve close approaches to wildlife for purposes of identification or photography, the potential for negative effects is large" (Knight and Cole 1995). In a 1989 survey conducted by Service, 403 of 478 (84 percent) refuge units allowed wildlife observation (U.S. Fish and Wildlife Service 1990). On two (1 percent) units where the Service had legal authority to control wildlife observation (n=363), the wildlife observation program was considered incompatible. On 15 refuge units (4 percent), wildlife observation was considered harmful to wildlife.

Boyle and Samson (1985) concluded that"human visits to passerine and waterfowl nests can increase the chances of nest losses through predation (Dwernychuk and Boag 1972, Bart 1977, Lenington 1979). Colonial nesting birds are particularly vulnerable to disturbance (Buckley and Buckley 1978, Manuwal 1978), as breeding populations concentrate in small areas and eggs and young are defenseless when adults are absent. Human disturbance of waterbird colonies has been shown to cause nest losses through interspecific predation (Schreiber and Risebrough 1972, Anderson and Keith 1980), intraspecific predation (Hand 1980), trampling (Johnson and Sloan 1976), and nest abandonment (Hunt 1972, Ellison and Cleary 1978)." Erwin (1980) suggested that colonial nesting waterbirds relocated to less preferred habitat in response to recreationists. Recreation intensity values between 7.8 and 37.0 visitors per hectare resulted in decreased bird densities in the Netherlands (van der Zande and Vos 1984).

Glinski (1976) wrote that "visits to active raptor nests usually result in an unfortunate waste of energy by the adult hawks that fly around the nest tree and call at the intruders". He also suggests that taped vocalizations utilized by some birders "disrupt the circadian rhythms that dictate performance of territorial calling and displaying during certain times of the day" thus prompting abnormal responses which not only expend energy, but could increase susceptibility to predation for both the individual and the nestlings.

Birds frequently approached by people may avoid foraging habitat. Burger and Gochfeld (1991, as cited by Rodgers and Smith 1997) found that foraging time of sanderlings decreased and avoidance (e.g., running, flushing) near human activities increased as the number of humans within 100 meters increased. At Ding Darling NWR, Klein (1993) experimentally tested waterbird behavioral responses to five human disturbance treatments: (1) driving by the waterbird; (2) stopping the vehicle within sight of the bird and remaining in the vehicle; (3) stopping the vehicle within sight of the bird and getting out of the vehicle to look at the bird; (4) stopping the vehicle within sight of the bird, getting out and slowly approaching the bird; (5) stopping the vehicle within sight of the bird, remaining in the vehicle and playing a noise tape. Klein found that as intensity of disturbance increased, avoidance response by the waterbirds tended to increase. Her results indicated that out-of-vehicle activity is more disruptive than vehicle traffic. Most birds, including brown pelicans, double-crested cormorants, anhingas, great blue herons, pied-billed grebes, and blue-winged teal, fled when approached by a person on foot. Although less disruptive than approach on foot, noise caused avoidance behavior by pelicans and cormorants. Klein concluded that approaching birds on foot was the most disruptive aspect of the usual visitor activities (nature observation, photography, fishing, crabbing, shell collecting, boating, fitness, or driving). Klein (1993) also observed refuge visitors and found that photographers were more likely to stop and leave their vehicles than groups with other purposes for visiting the refuge; thus, photographers disturbed waterbirds more than people observing nature, and more than people fishing and crabbing. Although nature observers also frequently stopped, they were less likely to leave their vehicles than photographers. Gabrielsen and Smith (1995) suggested that physiological responses to humans are more dramatic than responses to vehicles for most animals, "probably because mechanical disturbance is most often very brief, while humans walking take more time to cover the same distance, and thus have a much more profound effect."

Burger (1981) examined the effects of human activity on roosting and migrating birds at a costal bay refuge along the Atlantic coast. Human activities which involved rapid movements or close proximity to roosting birds, such as jogging or grass mowing, cause the birds to flush; in comparison, slow-walking bird watchers and clammers did not usually cause birds to flush. Burger also reported species differences in response to human activities. Herring gulls and common terns were least affected by human activity and usually returned to where they had been, ducks (mallards, black duck, American widgeon, and greater scaup) usually flushed and relocated to the nearby pond or bay; whereas herons, snowy egrets, and shorebirds (dowitchers, dunlin, black-bellied plover, and small sandpipers) were most disturbed by human activity and flushed to distant marshes. Burger found that waterbirds were present 42 percent of the time when people were present compared to 72 percent of the time when people were absent.

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Considerations to Reduce Disturbance

Boyle and Samson (1985) concluded that recreation management involves restrictions on human impacts on the environment. "Methods of limiting effects of recreationists on wildlife include location and design of facilities, designation of viewing or special-use areas, and establishment of larger refuges in which certain activities may be prohibited or regulated. Data are often unavailable for use as guides in planning habitat size and juxtaposition for optimum recreation and wildlife management" (Boyle and Samson 1985). Klein (1993) recommended providing visitors with observation and photography blinds to reduce the perceived need for approaching birds. Recommendations to reduce the level and intensity of use for wildlife observation, motorized tour routes, and photography on some national wildlife refuges included establishment of "stay in vehicle" zones (U.S. Fish and Wildlife Service 1990).

Burger (1981) recommended that if management objectives include providing roosting areas for migrating shorebirds, then some areas must be protected from close and fast-moving human activities. Buffer zones to protect wading bird (Ardeidae spp.) nesting colonies have been recommended from 100 to 250 meters (Vos et al. 1985, Erwin 1989, Rodgers and Smith 1995 as cited by Rodgers and Smith 1997). When exposing waterbirds to four types of human disturbances (walking, all-terrain vehicle, automobile, and boat), Rodgers and Smith (1997) concluded that a buffer zone of 100 meters would minimize flushing of foraging or loafing waterbirds in Florida. However, the authors also cautioned that other species or local populations may be more or less sensitive than those in their study.

Larson (1995) provides a case study in Colorado on balancing wildlife viewing with wildlife impacts. Chatfield State Park Wildlife Viewing Area (Chatfield WVA) was designed to achieve three goals: (1) to provide the public with opportunities to view the nesting activities of colonial waterbirds; (2) to enhance visitor experiences by providing educational opportunities that highlight human-wildlife interactions and the natural history of colonial waterbirds; and (3) to protect the waterbird colony by promoting an understanding of human impacts on the environment. Based on expert opinion and scientific literature, the park was developed and managed with three main strategies: (1) spatial and temporal zoning of human activities; (2) visitor education and interpretive programs; and (3) law enforcement. Zoning was the primary strategy for protecting birds during sensitive periods and controlled visitor access. Between March 1 through April 30 (during a period when human disturbance-related abandonment is high), visitor access was restricted to as far as the viewing shelter, which was 150 meters from the closest nest tree. Prearranged, guided groups were allowed on the viewing deck (75 meters from the closest nest tree) between May 1st and 15th, while colonial nesting birds were still nesting but less likely to abandon nests. Normal public assess throughout the entire Chatfield WVA was allowed from mid-May through February.

A vital persuasion technique emphasized at Chatfield WVA was the recruitment of uniformed volunteers to model appropriate behaviors for visitors and to conduct educational programs. Interpretive panels that gave visitors information about the consequences of their behaviors, suggested appropriate behaviors, and actively attempted to persuade the visitor to behave in a certain manner by using reasoned arguments.

Facilities at Chatfield WVA were designed to minimize human disturbance and included (1) tangential approaches to the viewing deck and pods with respect to nesting colonies; (2) the trail to the viewing deck was built below ground level, minimizing the probability that herons would see approaching people; (3) installing timbers of various heights to disrupt human profiles; (4) leaving existing vegetation to block the birds' view of approaching people; and positioning the viewing deck so that people will be obscured by an embankment. To assess possible impacts of the Chatfield WVA on the waterbird colony, a four-year field study was initiated, two years pre-construction and two years post-construction, as well as a long-term monitoring program.

Wildlife Photography

In a 1989 survey conducted by the Service, 392 of 478 (82 percent) refuge units allowed wildlife photography (U.S. Fish and Wildlife Service 1990). In 1 (>1 percent) case where the Service had legal authority to control wildlife observation (n=354), the wildlife photography program was considered incompatible. On 13 refuge units (3 percent), wildlife photography was considered harmful (U.S. Fish and Wildlife Service 1990).

At "Ding" Darling National Wildlife Refuge, Klein (1993) found that approaching birds on foot was the most disruptive aspect of the usual visitor activities (nature observation, photography, fishing, crabbing, shell collecting, boating, fitness, or driving). She found that wildlife photographers were the most likely to stop, leave their vehicles and approach wildlife and, therefore, were the most disruptive of visitor activities. Even slow approach by photographers disrupted waterbirds. Although nature observers also frequently stopped, they were less likely to leave their vehicles than photographers. Morton suggested that casual photographers often use inexpensive cameras with relatively short lenses, thus encouraging closer proximity to wildlife.

Advanced or professional photographers may practice extreme patience, waiting in view of or hidden from wildlife in order to take wildlife photographs. Frans Lanting, widely recognized wildlife photographer, said his favorite approach to obtain wildlife photographs is to habituate animals to the extent that they ignore him (Dobb 1998). Lanting stood for hours at a time, over the course of several days, waist-deep in an African watering hole in order to take photos of elephants and other wildlife (Dobb 1998). However, not mentioned are the impacts of this type of disturbance on wildlife; Lanting's presence presumably prevented some wildlife from using the waterhole for a period of time until they habituated to his presence or until his departure from the area.

Considerations to Reduce Disturbance

Klein (1993) recommended that refuges provide observation and photography blinds to reduce disturbance of waterbirds when approached by visitors. Photography blinds are provided for visitors on a reservation basis at Sacramento NWR, California. Photographers are required to enter the blind before sunrise and may leave the blind only once to depart from the area in order to reduce disturbance to wildlife.

The North American Nature Photography Association (NANPA) recommends the following ethical field practices as promoting the well-being of locations, subjects and photographers. NANPA suggest that the following principles will encourage all who participate in the enjoyment of nature to do so in a way that best promotes good stewardship of the resource.

1. Environmental knowledge of subject and place
    - Learn patterns of animal behavior. Know when not to interfere with animals' life cycles.
    - Respect the routine needs of animals. Remember that others will attempt to photograph them, too.
    - Use appropriate lenses to photograph wild animals. If an animal shows stress, move back and use a longer lens.

- Acquaint yourself with the fragility of the ecosystem. Stay on trails that are intended to lessen impact.

2. Social knowledge of rules and laws
    - When appropriate, inform managers or other authorities of your presence and purpose. Help minimize cumulative impacts and maintain safety.
    - Learn the rules and laws of the location. If minimum distances exist for approaching wildlife, follow them.
    - In the absence of management authority, use good judgment. Treat the wildlife, plants and places as if you were their guests.
    - Prepare yourself and your equipment for unexpected events. Avoid exposing yourself and others to preventable mishaps.

3. Individual: Expertise and Responsibilities
    - Treat others courteously. Ask before joining others already shooting in an area.
    - Tactfully inform others if you observe them engaging in inappropriate or harmful behavior. Many people unknowingly endanger themselves and animals.
    - Report inappropriate behavior to proper authorities. Don't argue with those who don't care; report them.
    - Be a good role model, both as a photographer and a citizen. Educate others by your actions; enhance their understanding.

Environmental Education and Interpretation

Clark and Stankey (1979) recommended that managers "provide adequate information about what one will find there so that users can make choices about where to go in keeping with their preferences and expectations." Klein (1993) found that visitors who were in contact with staff at the "Ding" Darling NWR were less disruptive of wildlife than other recreational users. She concluded that the personal attention gained from a guided tour could be especially effective. Klein recommended that visitor education stress reducing the incidence of people approaching animals on foot. Aitchison (1977) suggested that problems between wildlife and human recreationists may only be mitigated through education. Purdy et al. (1987) stated that "education of the public about the values of wildlife is essential for the protection and wise use of wildlife (Bird 1978). Visitors are entitled to wildlife-viewing experiences, but must be educated about wildlife behavior and the need to maintain respect for wild animals (Bell 1963, Glinski 1976, Olsen and Olsen 1980). Of course, a potential problem with such education is that in some situations, increased public education and awareness may increase interest and demand for the resource, thus leading to increased disturbances of wildlife (Nisbet 1979). However, education is often the least offensive method of control available to managers because it preserves visitors' freedom of choice." Informed management decisions coupled with sufficient public education could do much to mitigate disturbance effects of wildlife-dependent recreation (Purdy et al. 1987).

In a 1989 survey conducted by the Service, 191 of 478 (40 percent) refuge units conducted an environmental education program (U.S. Fish and Wildlife Service 1990). In all cases where the Service had legal authority to control the environmental education program (n=190), the program was considered compatible. On four refuge units (2 percent) the environmental education program was considered harmful (U.S. Fish and Wildlife Service 1990).

One method suggested by NWR Managers (Region 5, northeastern United States) for mitigating visitor-activity impacts on wildlife was visitor education. Managers recommended that refuge staff: (1) educate visitors about the human impact on wildlife and provide general environmental education programs about wildlife; (2) provide informational brochures, leaflets, and news releases which build public awareness of impact; (3) provide hunter education; (4) place weatherproof cards on nest boxes to explain their purpose; and (5) require hunters to take a waterfowl identification exam (Purdy et al.1987). Miller et al. (1998) recommended recreationalist education that informs visitor on how their activities affect wildlife and how they can minimize impacts, for example by remaining on trails and keeping pets leashed.

In Colorado, Manfredo and Larson (1993) assessed public preferences for recreation that occurred on trips where wildlife viewing was the primary purpose and presented a classification of wildlife viewers to assist land managers in developing wildlife viewing management programs. Four types of wildlife viewing experiences were identified: High Involvement Experiences, Creativity Experiences, Generalist Experiences, and Occasionalist Experiences. The goals for environmental education and interpretation programs may differ among the experience types. For the High Involvement and Creativity Experiences, environmental education and interpretation programs should focus on enhancing the process of visitor selecting and experiencing wildlife viewing. For the Generalist and Occasionalist Experiences, environmental education and interpretation programs should focus on developing the product that will be experienced. "For example, Creativity and High Involvement Experiences could be enhanced by providing information on when and how to engage in wildlife viewing, technical information on wildlife, and information on how to engage in activities associated with wildlife viewing such as painting or photography. Preparation of specific sites for visitation would involve only low levels of development (e.g., blinds, trails, signs) that facilitate self-discovery. Experiences for Generalists and Occasionalists would be provided by developing specific destinations (i.e., experience "product") such as visitor centers, roadside exhibits, and interpretive centers. A low degree of self-discovery would be necessary; exhibits would show or describe wildlife, or captive species would be available for viewing. In some cases, the participant may never actually see wildlife in a natural setting" (Manfredo and Larson 1993). High Involvement Experiences and Creativity Experiences would be distinguished from one another primarily by information content. Creativity Experiences seek information about activities such as painting or photography. High Involvement Experiences seek information about wildlife biology or about being involved in amateur wildlife research projects.

Activities Associated with Wildlife Dependent Recreational Uses

Boating

Dahlgren and Korschgen (1992), categorized human activities in order of decreasing disturbance to waterfowl: (1) rapid overwater movement and loud noise (power-boating, water skiing, aircraft); (2) overwater movement with little noise (sailing, wind surfing, rowing, canoeing); (3) little overwater movement or noise (wading, swimming); and (4) activities along shorelines (fishing, birdwatching, hiking, and traffic). In support of this, Hume (1976 as cited by Dahlgren and Korschgen 1992) observed similar differential response of waterfowl to human activities. Common goldeneyes often flew when people on the shore approached closer than 100 or 200 m, but settled elsewhere on the water. A single sailing dinghy, however, was sufficient to cause more than 60 common goldeneyes to take flight and most to leave entirely within a few minutes. Remaining birds then flew up each time the boat approached to within 300 to 400 meters and generally left within an hour. The appearance of powerboat caused instantaneous flight by most birds. If the boat traversed the length of the reservoir, all remaining birds left within minutes. Hume reported that waterfowl abundance decreased over time as a result of increased frequency of boating.

Likewise, Tuite et al. (1983) found that waterfowl distribution on inland waters in England and Wales was affected by water-based recreation but that the effect varied by type of activity and species of waterfowl. Fishing, sailing, and rowing reduced the abundance of waterfowl in winter the most; where the presence of birdwatchers was associated with higher-than-expected numbers of most species. Wintering green-winged teal, northern shoveler, and common goldeneye were the most susceptible species to disturbance; the most tolerant were the mute swan, tufted duck, common pochard and mallard. Jahn and Hunt (1964) also documented differential tolerance by species to boating disturbances. American coot, blue-winged teal, mallard and wood duck were the most tolerant to disturbance. Parr (1974 as cited by Dahlgren and Korschgren 1992) found that mallards seemed generally tolerant to sailboats but the abundance of green-winged teal in the post-sailing period decline by half.

"Total number of boats and people can be an inappropriate measure of recreational intensity because the presence of a single boat might be just as disturbing as that of many (Tuite et al. 1983, Knight and Knight 1984). Likewise, not all types of boats are equally disruptive to wildlife. Motorboats have the greatest disturbance potential because they involve both movement and noise, whereas sailing and canoeing are less disruptive as they involve only movement (Tuite et al. 1983)" (Knight and Cole 1995).

In Denmark, Kahlert (1994) found that fast-moving boats (fishermen, windsurfers and motor boats) have the greatest impact on red-breasted mergansers broods as frequency of encounters and rate of disturbance were highest. Broods responded twice as often to the fast moving boats compared to other boats (sailing boats, rowing boats, canoes, and rafts) and people walking. The presence of fast-moving boats also caused the most significant modifications to time budgets. However, merganser broods are considered quite resilient to moderate disturbance levels, interruptions to comfort behavior were compensated within 1 ½ hours. Kahlert (1994) suggested that in some species, compensatory foraging is apparently not needed (e.g., Eider ducks: Keller 1991, coots: Nielsen 1991) because little foraging time is lost due to disturbance either because of tolerance or adaptation to human presence.

Boating activity can be detrimental to bald eagles because it disrupts feeding activity and affects large areas in short periods of time (Skagen 1980, Stalmaster 1980 as cited by Knight and Knight 1984). Disturbance may result in increased energy expenditures due to avoidance flights and decreased energy intake due to interference with feeding activity (Stalmaster 1983 as cited by Knight and Knight 1984). Stalmaster and Newman (1978) reported that human activity was found to affect eagle distribution and behavior adversely. Distribution patterns were significantly changed, resulting in displacement of eagles to areas of lower human activity. Activities occurring on the river, such as boating and fishing, were most disturbing if activities did not regularly occur there. Buehler et al. (1991) found that few eagles used shoreline segments with boats or nearby pedestrians. Stalmaster and Newman recommended activity restriction zones and vegetation buffer zones. Similarly, Burton et al. (1996) documented a decline in roosting numbers of shorebird species in Hartlepool West Harbour, England and concluded that the increased rate of disturbance from boats may partly explain the decline.

Motorboats and Airboats

Speed and approach of boats can influence wildlife responses. Rapid movement directly toward wildlife frightens them, while movement away from or at an oblique angle to the animal is less disturbing (Knight and Cole 1995). Ames and Mersereau (1964 as cited by York 1994) documented that eggs were lost from nests of osprey because motorboats speed along in close proximity to the nests. Incubating osprey attempted to escape discovery by remaining on the nest as long as possible. However, with rapid approach of boats, osprey flushed directly from the nest, breaking and dragging eggs as they flew. Likewise, Mabie et al. (1989) concluded that direct approach of airboats caused a detectable change in alert behavior among four family groups of whooping cranes. They suggested that responses of cranes to direct approach of airboats indicated that changes in use of territories by cranes were possible if airboat use occurred frequently within family group territories. Jahn and Hunt (1964) concluded that airboats posed a serious threat to waterfowl production in Wisconsin because airboats easily invade shallow-water areas that are of most value to waterfowl. Kahl (1991) reported that canvasbacks were less likely to flush for slow-moving boats compared to fast-moving boats.

Motorized boating in Minnesota caused nest desertion by common loons, whereas the presence of canoe travelers did not (Titus and Van Druff 1981 as cited by Knight and Cole 1995). Reichholf (1976) reported heavy clutch losses as a result of boating disturbance. Especially sensitive to passing boats were clutches of waders, gulls, and terns that are easily detected by predators. Losses were also high in grebes and some duck species. In Alaska, Mickelson (1975) noted motorized boats caused goose families to flee and broods to separate. The separated goslings were susceptible to predation by glaucous gulls. The author suggested that human activities such as boating be restricted on waterfowl nesting and brood-rearing grounds to reduce predation on young birds.

Knight and Cole (1995) suggested that energy expenditures equating to survival must be considered in the post breeding season. During post-breeding molting, waterfowl appeared to be negatively effected by recreational boat use (Sterling and Dzubin 1967, Bergman 1973, Speight 1973). Sterling and Dzubin (1967) concluded that boating disturbance caused some groups of molting Canada geese to desert molt sites.

Consequences of boating impacts on aquatic vegetation depend on the time of year boating occurs in relation to the phenology of the plants and the animal activities (Liddle and Scorgie 1980). For example, many water plants spend the winter in a resting stage and are not likely to be damaged at that time. However, boating, other recreational activities and management operations may help to disperse reproduction structures or vegetative fragments of plants and thus aid their survival. Increased distribution and survival could be beneficial process when dealing with desirable plants or detrimental when dealing with undesirable plants. Propellers cut aquatic vegetation at varying degrees dependent on shaft depth and propeller size and speed of rotation (Crossland 1976, Lagler et al. 1950 as cited by Liddle and Scorgie 1980). Damage to emergent macrophytes by boats running into them at right angles to the shoreline, and by boats turning, leaving isolated patches of plants, was record by Sukopp (1971 as cited by Liddle and Scorgie 1980). Haslam (1978 as cited by Liddle and Scorgie 1980) observed that low levels of boating activity had greater number of aquatic plants species growing in canals than high levels of boating activity.

Boating can reduce water quality. Wall and Wright (1977) reported that 3.3 grams of oxygen are consumed in the oxidation of 1.0 grams of oil. Oxygen content of the first few centimeters can be depleted in this process and reduce phytoplankton production in lakes. In addition, as much as 16 of 160 liter of gasoline from outboard motors may be discharged into the water. Fish flesh is tainted at a fuel-usage level of 32 liters of motor fuel per 4 million liters of lake water per season. Yousef et al. (1980) report a substantial increase in turbidity and phosphorus concentrations on shallow lakes.

In 1978, Braun et al. reported that 42 NWR permitted high speed boating. Of those refuges allowing high speed boating, in most cases the Service had secondary control and another agency retained primary jurisdiction. Braun et al. (1978) concluded that boat-related disturbances with little or no consideration of the value of wetlands and associated water birds have no place on NWRs. Furthermore, they stated that when threatened or endangered species are impacted by such activities, closure of refuges to boats should be mandatory.

In 1989, 188 of 478 refuge units (39 percent) surveyed reported recreational motorboat use (U.S. Fish and Wildlife Service 1990). Of the 188 units, the Service did not have legal authority to control motorboat use on 131 (70 percent) units, 34 units considered motorboats harmful (18 percent) and 10 (5 percent) units reported that the frequency of the recreational motorboat use was considered incompatible with wildlife (U.S. Fish and Wildlife Service 1990). Recreational motorboat use was identified as one of the 16 secondary uses most frequently listed as not compatible by refuge managers (U.S. Fish and Wildlife Service 1990).

Similarly, 20 of 478 (4 percent) refuge units surveyed reported recreational airboat use (U.S. Fish and Wildlife Service 1990). Of the 20 units, the Service did not have legal authority to control recreational airboat use on six (30 percent) units, and six (30 percent) units reported that the frequency of the recreational airboat use was considered incompatible with wildlife (U.S. Fish and Wildlife Service 1990). Recreational airboat use topped the list of the 16 secondary uses that were most frequently listed as not compatible by refuge managers. Recreational airboat use was specifically identified as not compatible on Stillwater NWR and Fallon NWR (U.S. Fish and Wildlife Service 1990).

Canoes and Slow-moving boats

Canoes and slow-moving boats can negatively impact waterbird distribution and abundance. In Germany, Bauer et al. (1992) noted that the wintering goldeneye population decreased significantly as the number of boats, primarily canoes and rowboats, increased on the lake. Kaiser and Fritzell (1984) reported that green-backed heron activity declined on three of four survey routes when canoes and boat use increased on the main river channel of the Ozark National Scenic Riverway. Olsen and Olsen (1980 as cited by York 1994) reported that anglers in slow moving power boats that passed directly beneath a peregrine falcon nest created more disturbance than fast moving power boats pulling water-skiers that passed within 50 meters of a nest.

However, Knight and Knight (1984) found that bald eagles perched in trees along the Skagit River, where boating activity was high, flushed less often when approached by a canoe than eagles along the Nooksack River, where there was little boating activity. Knight and Knight suggested that eagles habituate to boating activity in the absence of persecution or rewards. Habituation may explain instances of negligible impacts of boating disturbance, exemplified by daily activities of ruddy shelducks in Royal Chitwan National Park (Hulbert 1990). Wildlife species may also show a differential response to boating disturbance. Groom (1990 as cited by Haysmith and Hunt 1995) studied disturbance responses of 59 species of passerines along a river corridor in Manu National Park, Peru. Of these species, 22 were rated insensitive because they fled from boats rarely, 18 species were moderate, flushing from boat traffic 35 to 65 percent of the time, and 19 were considered sensitive because boating always precipitated a flushing response. A differential response to boating disturbance by avian species likely occurs in the United States as well.

Canoes and rowboats, because of their shallow droughts, can penetrate farther into the shallows and therefore cause considerable disturbance to nesting waterbirds (Speight 1973). Vos et al. (1985) reported that canoes or slow-moving boats caused disturbance to nesting great blue herons and recommended buffer zones of 150 meters in water and 250 meters on land around nesting sites from mid-February through early August. Motorized boating caused nesting failure by common loons (Vermeer 1973), whereas the presence of canoe travelers did not (Titus and Van Druff 1981). However, canoeist camping on islands caused significant disturbance to nesting loons (Ream 1976).

Migrating and Wintering Birds - Airboats

In Wisconsin, Bartelt (1987) concluded that airboat disturbance (along with some helicopter disturbance to a lesser degree) at roosting areas influenced the likelihood of radio-marked Canada geese being shot more than hunting pressure. In 1979, a year with a high harvest quota and high disturbance at roosting areas, 37 percent of family members were killed, at least one member from every family group. In 1980, a year with a high harvest quota but low disturbance, 10 percent of family members were shot from 40 percent of family groups. In 1981, a year with a low quota and low disturbance, 8 percent of family members were shot from 33 percent of family groups. Bartelt concluded that disturbance on roosting sites may decrease the cohesiveness of family groups and increase hunting mortality.

Along the Texas gulf coast, Mabie (1985) reported that some hunters attributed a decline in hunting quality to increased use of airboats. On four days during the waterfowl hunting season, Mabie experimentally flushed waterfowl from an airboat and documented the flush distances from an aircraft. Although sample sizes were small, Mabie reported that waterfowl moved temporarily from one area to another, but generally returned to the area. The average flushing distance of redheads from the airboat was estimated at 0.6 mile and average distance flown before landing was estimated at 1.2 miles. Northern pintail and/or gadwall flushed at 0.3 mile from the airboat and flew 0.9 mile before landing. The number of redheads on Pringle Lake prior to the four-days of experimental airboat disturbance was similar to the number following disturbance; however, the four-day period may not have been sufficient to determine any difference. Mabie concluded that decreases in waterfowl abundance were attributed to changing land use activities in the northern prairie region, as well as reduction of habitat quality and quantity along the Texas gulf coast and not current levels of airboat use. Although Mabie (1985) recommended in his report that boat traffic in the shallow bay systems of the island not be regulated, by 1997, airboats were prohibited during the hunting season in response to safety concerns and to allow for a quality hunting experience (D. Mabie, Texas Parks and Wildlife Department, pers. comm.1998).

Speed and approach of boats can influence wildlife responses. Rapid movement directly toward wildlife frightens them, while movement away from or at an oblique angle to the animal is less disturbing (Knight and Cole 1995). Mabie et al. (1989) concluded that direct approach of airboats caused a detectable change in alert behavior among four family groups of whooping cranes. However, mimicked hunter activities (airboats and outboard motorboats) at an average distance of 600 meters to cranes did not significantly increase alert behavior in cranes, an unhunted species.

Migrating and Wintering Birds - Motorboats

Korschgen et al. (1985) stated that motor boating and hunting are the two main activities that disturb waterfowl in the upper Midwest. In Connecticut, Cronan (1957) found that selection of feeding sites by lesser scaup was influenced by disturbances such as hunters, anglers, and pleasure boaters. During the fall and spring, few scaup foraged where people were fishing or boating. In Germany, Bauer et al. (1992) concluded that boating pressure on wintering waterfowl had reached such a high degree that establishing larger sanctuaries, stopping water sports and angling from October to March, and imposing a permanent ban on hunting was necessary. Jahn and Hunt (1964 as cited by Korschgen et al. 1985) suggested that even the best habitats will be lightly used, if used at all, by migrant ducks if human disturbance is excessive. Likewise, Thornburg (1973) observed on numerous occasions boaters initiating mass flights of diving ducks on the Keokuk Pool of the Mississippi River. He believed that increased hunting activity and boating could pose a serious threat to the continued use of the area by great numbers of migratory waterfowl. Thornburg concluded that eventually restrictions on boating activity may be necessary and that establishment of a sanctuary should be considered. Havera et al. (1992) also studied human disturbance of waterfowl on the Keokuk Pool and concluded that a refuge, inviolate to boating, should be established in spring and fall for migrating waterfowl.

In Wisconsin, Kahl (1991) reported a differential canvasback response to different levels of boating disturbance. Kahl noted that at an average of 1.0 and 1.1 boating disturbances (hunting and fishing) per hour, disturbance had an increasing effect on the flock reaction to each successive disturbance. After several days of frequent disturbance, canvasbacks established midlake loafing sites where disturbance was minimal. Most canvasbacks flew directly to these loafing sites after a disturbance, and these birds attracted other small groups of canvasbacks. Thus, a smaller proportion of the entire flock successively returned and was exposed to the greater levels of disturbance at feeding sites.

In comparison, Kahl (1991) observed that canvasback flocks exposed to an average level of 0.7 boating disturbances per hour never established distinct midlake loafing areas. Consequently, more canvasbacks in a flock returned directly to the feeding area after disturbance. Birds probably flew longer before returning because no flocks on nearby loafing sites attracted them and because these birds remained in flight longer to be sure that the threat on the feeding area had passed. The lower flock disturbance rate allowed canvasbacks greater access to feeding areas or the colder weather (associated with fewer boating disturbances) may have forced canvasbacks to return more quickly to feeding areas due to increased energy demands (Takekawa 1987 as cited by Kahl 1991). Although not quantified, Kahl noted that canvasbacks were less likely to flush and flushed at closer distances in response to slow-moving boats than fast-moving boats.

Kahl (1991) reported that energetic costs to canvasbacks as a result of boating disturbance averaged 14 to 21 kilocalories per day for flight plus incremental feeding activity to compensate for this flight. Maximum daily energy costs of flight for an individual responding to all disturbances would have been 46 to 60 kilocalories. Kahl (1991) concluded that the "frequency of disturbance (avg. 0.7 to 1.0 boating disturbance per hour) and limited daylight access to food resources documented in this study suggest that human disturbance is an important management concern. Management plans for protection and restoration of canvasback staging habitats should include alternatives for regulation of boating disturbance through spatial or temporal restrictions, or both." Kahl proposed five management alternatives for consideration: (1) inviolate sanctuaries, (2) voluntary compliance refuges, (3) no-wake or nonmotorized boating zones, (4) fishing or hunting restrictions, or both; and (5) public awareness campaigns.

Korschgen et al. (1985) observed canvasbacks on the backwater of the Mississippi River, Lake Onalaska of which 81 percent of the area was closed to hunting. Although not quantified, canvasbacks became more sensitive to motorboats over time and on many occasions the flushing distance extended as far as one kilometer. Not only did the flushing distance increase as fall progressed, but the number of birds flushed also increased. Korschgen et al. (1985) suggested that waterfowl use could be enhanced by increasing the food supply or decreasing the number of disturbances. Canvasback disturbance by recreational boaters averaged 5.2 disturbances per day and may have caused birds to fly approximately one hour per day in response to disturbances (Korschgen et al. 1985). Canvasbacks would need an additional 75 kilocalories per day of wildcelery to compensate for the boating disturbance. Korschgen et al. noted weight gains of canvasbacks and estimated that 60 percent of wildcelery remained following the birds departure. He concluded that food resources appeared sufficient during the study to meet the needs of the canvasback population despite the level of boating disturbance. However, the authors warned that energetic costs of disturbances may have detrimental effects should the canvasback population significantly increase and require more food, American wildcelery winter bud production significantly decrease, disturbances become more frequent, or other migration areas deteriorate.

Breeding Birds

Timing of boating use has implications to waterbirds. During the breeding season, disturbance may affect nest abandonment, predation on young, or subject young birds to environmental stress. In Florida, Rodgers and Smith (1997) noted that human disturbance can have significant adverse effects on wildlife, and that breeding colonial waterbirds are particularly susceptible because of their high-density nesting habits. They recommended a minimum distance to nesting colonies of 125 meters for wading birds and 175 meters for terns from pedestrian and outboard motor boat disturbance. Buckley and Buckley (1976) recommended that boats should be kept 200 meters from island occupied by colonial nesting waterbirds. Reichholf (1976) noted that power boats' bow wake tipped over nests near the fringe of reeds, as well as free-floating grebe nests. Another study demonstrated boating impacts to reproductive success of waterfowl. In Maine, after the use of motorboats was prohibited from the marsh portion of a lake, brood size increased by an average of two birds (Mendall 1958).

Bouffard (1982) provides a case study of boating (fishing and waterskiing) impacts on breeding waterfowl at Ruby NWR, Nevada and a lawsuit brought against the Service to bring the refuge in compliance with compatibility standards. Ruby Lake NWR contains one of Nevada's few remaining wetland areas and in the past has been a major breeding area for canvasbacks and redheads. In the early 1930s, largemouth bass were stocked in the marsh. At first anglers were relatively few and fished primarily from the shore; however, over the years the number of anglers, the number of boats and motor size increased. In 1980, Bouffard reported 65,568 visits to the refuge, of which 90 percent involved fishing and 65 percent involved fishing from boats (average motor size was 90 horsepower). The heaviest public use coincided with the waterfowl breeding season and boating associated with fishing and waterskiing caused considerable disturbance to breeding diving ducks. Courting canvasback and redhead pairs flushed an average of 271 meters from any boat regardless of motor size (Howard 1978 as cited by Bouffard 1982). Noise from outboard motors flushed canvasbacks and redheads off their nests at an average of 35 m, and some flushed over 100 meters away (Bouffard 1980 as cited by Bouffard 1982). Few hens covered their nest when flushed, exposing the eggs to chilling, overheating, or predation by ravens. Repeated flushing of birds and anchoring of boats near nests led to nest desertion. In 1971, research by Napier (1972 as cited by Bouffard 1982) documented lower redhead nest success in the public use area (61.1 percent) than in the control area (93.6 percent). Boats dispersed broods and forced them into less desirable habitat (Bouffard 1982). In addition to disrupting breeding waterfowl, boats also caused habitat damage. The cutting action of propellers totally removed the aquatic vegetation in some channels and changed the species composition of the vegetation in other areas. Areas with heaviest boat use had less submergent vegetation (10 7 tons per acre) than non-use areas (45.9 tons per acre; U.S. Fish and Wildlife Service 1976a as cited by Bouffard 1982).

The Service moved to protect the waterfowl resource by restricting motorboats on the refuge. Unsatisfied with proposed changes, the Defenders of Wildlife sued the Service to stop the liberal recreational boating on Ruby Lake NWR which they contended was a violation of the Refuge Recreation Act. The outcome was the establishment of boating regulations that greatly reduced wildlife disturbances and with minor changes are still in effect today. Motorless boats and boats with electric motors were allowed in one area from June 15 through December 31, boats with outboard motors no larger than 10 horsepower were allowed August 1 through December 31 (Bouffard 1982).

Recreational activities may have compounding effects when occurring simultaneously. For example, at a reservoir in South Wales, sailing caused little waterfowl disturbance because it occurred in deep waters while most waterfowl preferred shallow areas. However, when bank fishing from the shoreline and from boats occurred, waterfowl retreated to the deeper central waters where they encountered sailboats.

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Angling and sailing, therefore, resulted in birds being deprived of any part of the reservoir (Bell and Austin 1985).

In Colorado, Vos et al. (1985) reported that nesting herons became habituated to repeated non-threatening activities such as anglers boating past a heronry. Boats passing the heronry caused minimal responses by herons 92 percent of the time. Authors recommended buffer zones of 150 meters in water and 250 meters on land around nesting sites from mid-February through early August. In contrast, Anderson (1978) reported fishing and boating negatively impacted nesting wading birds on the Texas Gulf Coast.

Driving

Vehicular Travel and Roads

Hosier and Eaton (1980) stated that "vehicles may affect natural vegetation by reducing plant cover and height, lowering species diversity, and altering community composition (Bates 1935; Chappell et al. 1971; Trew 1973; Liddle and Greig-Smith 1975b; Boorman and Fuller 1977). Godfrey et al. (1978) found that growth of plants in berm and marsh areas of Cape Cod National Seashore was inhibited by vehicular traffic and the faunal populations were subject to crushing and habitat alteration. Liddle and Greig-Smith (1975a) found that vehicular traffic compacted sub-surface layers in sandy soils." Hosier and Eaton (1980) compared two barrier beaches in North Carolina with respect to vegetation patterns and soil compaction. Vegetation cover and the number of avian species present on dunes and grasslands were fewer on the area subject to off-road vehicles. In addition, soil was more compact where vehicular traffic had been most intense, resulting in decreased plant cover and density. Compaction of dune soils would also lead to higher water content, thus altering substrate composition. This could hamper availability of correct substrate for pioneering native plant species. Hosier and Eaton concluded that vehicular traffic on Fort Fisher Beach was detrimental to the maintenance of the island system. Anders and Leatherman (1987) found similar effects occurring in the coastal foredunes of Fire Island, New York, and stated that even low-level off-road vehicle impacts severely damage dune vegetation. Busac and Bury (1974) suggested that off-road vehicle use in the Mojave Desert resulted in negative effects including loss of cover, reduction in invertebrate food sources, disturbance of social structure, and casualties.

Vehicles have been cited as exotic seed vectors in some instances. In a study conducted at Kakadu National Park in northern Australia, weed seeds were found to be carried into the park by tourist vehicles (Lonsdale and Lane 1994). However. Lonsdale and Lane argued that the low density of seeds entering the park in that manner, combined with the assumption that most seeds would either leave the park the same way or not survive to maturity prompted them to conclude "that it would be a waste of resources to attempt to prevent seeds from entering on vehicles".

In a 1989 survey conducted by the Service, 106 of 478 (22 percent) refuge units allowed wildlife tour routes (U.S. Fish and Wildlife Service 1990). In one (1 percent) case where the Service had legal authority to control wildlife tour routes (n=105), the wildlife tour route was considered incompatible. On four refuge units (4 percent) wildlife tour routes were considered harmful (U.S. Fish and Wildlife Service 1990).

Roads can cause habitat fragmentation and produce habitat edge effects. For example, Ferris (1979) and Hanowski and Niemi (1995) found that habitat interior species were less abundant and habitat edge species were more abundant near roads, as cited by Miller et al. (1998). Roads may provide corridors for some species by providing ribbons of habitat in areas adjacent to roads, but the effectiveness of this corridor requires more detailed analysis (Vermeulen 1994).

Raasch (1996) held that roads have a "dual negative affect" as far as wildlife is concerned. Destruction of habitat occurs when the road is built, and then the road provides human access to previously inaccessible areas. A third effect, mortality can also result from collisions between wildlife and vehicles (Purdy et al. 1987; Rosen and Lowe 1994). With respect to driving on the beach in close proximity to breeding shorebirds, Cox et al. (1994) stated that the "detriments to reproductive success may have included egg and nestling mortality, nest evacuation, reduced nestling mass or slower growth, premature fledging and modified adult behaviors. Disturbance to foraging and resting shorebirds was noted, although not quantified". An indirect effect of vehicular travel is the effect of noise on wildlife. Busnel (1978) suggested that noise (e.g., from a busy road) can mask communication.

Vehicular emissions such as gases, liquids and solids may lead to local and community wide air, water and soil pollution. Population densities of both plants and animals could be affected (Van der Zande et al. 1980).

However, auto touring is a method of wildlife observation that may be less disruptive to wildlife than other forms of transportation. Morton (1996) suggested that travel by vehicle is sometimes less disturbing to wildlife than travel by foot and the casual observer can sometimes gain a better vantage by remaining inside a vehicle. Likewise, Klein's research (1993) indicated that out-of-vehicle activity (nature observation, photography, fishing, crabbing, shell collecting, boating, fitness) was more disruptive than vehicle traffic. Klein concluded that approaching birds on foot was the most disruptive of the usual activities of refuge visitors. At Sacramento NWR during the hunting season, units along the auto tour route maintained pintails at similar proportions to seasonal wetland availability and similar to pre-hunting season proportions (Wolder 1993).

Some Refuge Managers recommended prohibiting driving between midnight and 5:00 am to reduce impacts of vehicles on wildlife (Purdy et al.1987). Sacramento NWR has enhanced wildlife viewing on the refuge's auto tour while aiming at reducing disturbance and meeting the needs of wildlife. For example, Sacramento NWR has an auto tour route that is open from sunrise to sunset. In addition, the refuge constructed loafing islands for waterbirds that could be easily viewed from vehicles on the auto tour route, uses emergent vegetation to help screen wildlife and is proposing an elevated vantage point to view wildlife from vehicles (D. Dachner, Outdoor Recreation Planner, U.S. Fish and Wildlife Service, pers. comm. 1999).

Hiking

Hiking

In a 1989 survey conducted by the Service, 329 of 478 (69 percent) refuge units allowed walking and hiking (U.S. Fish and Wildlife Service 1990). In five (2 percent) cases where the Service had legal authority to control wildlife observation (n=217), walking/hiking was considered incompatible. On ten refuge units (3 percent) walking and hiking was considered harmful to wildlife (U.S. Fish and Wildlife Service 1990).

A consequence of hiking is wildlife displacement (Knight and Cole 1995; Riffell et al. 1996) which can cause declines in species richness and abundance (Riffell et al. 1996). Raasch (1996) suggest that duck species can be forced to relocate to secondary sites which may be of inferior foraging quality.

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Researchers have reported on disturbances of trumpeter swans (Henson and Grant 1991), common sandpipers (Yalden 1992), golden plovers (Yalden and Yalden 1990) and snow geese (Bélanger and Bédard 1989) by various pedestrian recreational activities (cited by Knight and Cole 1995). Incidents of sandhill crane mortality occurring as a result of disturbance are suggested in a study conducted in the North Platte River area of Nebraska (Anderson 1995). The researcher reported that visitors moving near roosting or foraging sandhill cranes causes them to startle and flush. This expends energy and can cause injury or death through contact with power lines.

Skagen et al. (1991) demonstrated that a person approaching foraging avian scavengers (bald eagles, American crows and glaucous-winged gulls) disrupted foraging behavior and social dynamics of the guild. When disturbed, eagles flew a greater distance than crows, which in turn flew a greater distance than gulls. Eagles seldom returned to foraging site once flushed and fed at a site more on days of no human disturbance than days when feeding was disrupted. In contrast, human disturbance appeared to enhance feeding opportunities for gulls.

Displacement becomes a crucial issue during incubation or nesting periods. There are three basic effects during nesting: (1) egg exposure to heat or cold when adult is dislocated; (2) predation on eggs when nest is vacated by adult; and (3) predation on eggs at a later time due to predators following human trails or other markers to nest sites (Korschgen and Dahlgren 1992). This third effect is further exemplified by the study conducted by MacInnes and Misra (1972) who suggested that "predation losses would contribute little (about 10 to 12 percent) to the loss of productivity of Canada geese on the McConnell River [Northwest Territory, Canada] study area if human disturbance was absent". There is also evidence of conspecific predation in some species of gulls; the effects of which are intensified when human intrusion is added to the mix (Hand 1980). Strang (1980) suggested that gulls and jaegers prey on unattended nests, although there is not enough evidence to support the conclusion that they follow humans to prey on the nests. He further reported that it is not valid to assume that predators destroy the entire clutch.

Juveniles are also particularly vulnerable to displacement and become more susceptible to predation as suggested by Keller (1991). Eider broods when disturbed by hikers, windsurfers, anglers, and boaters became separated because the ducklings could not keep up with adults. The result was a greater chance of predation by herring and great black-headed gulls.

Effects of hiking into wildlife habitat can exhibit differing results due to habituation. Eberhart et al. (1989) report that Canada goose broods in metropolitan parks tolerate a fair amount of human disturbance when compared to broods found in areas devoid of human intrusion which responded by hiding in vegetation. Eagles in the Chippewa National Forest in north-central Minnesota responded in varying degrees to repeated intrusion. Some flushed at greater and greater distances with repeated disturbances, while others adapted (Fraser et al. 1985).

Habitat alteration occurring through trampling by hiking or walking affects not only vegetation but compacts the underlying soil allowing for the possibility of erosion (Liddle 1975; Hendee et al. 1990). Compaction also reduces seedling emergence through mechanical resistance of root penetration (Cole and Landres 1995). Along with reduced percent cover and biomass, reduced species abundance often occurs and only the most resistant species survive (Liddle 1975). Hiking, therefore, may impact vegetative succession. Raasch (1996) suggests the disturbance of vegetation not only results in an alteration of vegetation but a change in light and moisture as well as a topographical modification resulting in a reduction in ground and shrub-nesting avian species (Blakesly and Reese 1988).

A study of recreational-use impacts on national wildlife refuges in the northeast (Region 5) was conducted by surveying participating managers (Pomerantz et al. 1988). Of all activities conducted on the respective refuges, travel by foot and driving on beaches were listed as those with the highest variety of impacts to wildlife, "from direct mortality to aberrant behavior." Wildlife observation by foot travel was cited as being associated with lowered productivity as well as alteration of behavior or stress in shorebirds, waterfowl and birds of prey. Aberrant behavior or stress for the purposes of this study was defined as "unusual behavior or signs of stress that are likely to result in reduced reproductive or survival rates." Further, intrusion into an area by foot negatively impacted almost all 20 identified species groups (Pomerantz et al. 1988).

Trails

It is unclear whether the influence of recreational trails on bird communities is due to the physical presence of the trail or the associated human disturbance, however, Miller et al. (1998) suggests that both may act in concert. In mixed-grass prairie and forest ecosystems Miller et al. (1998) found that bird abundance, species composition and nest predation differed by distance from heavily-used recreational trails. Generalist species (American robin, black-billed magpies and house finches) were more abundant near trails, whereas specialist species (western meadowlark, vesper sparrow, grasshopper sparrow, western wood-pewee, chipping sparrow, pygmy nuthatch, solitary vireo, and Townsend's solitaire) were less common. For the majority of species, the trail zone of influence appeared to be approximately 75 meters. Similarly, Hickman (1990 as cited by Miller et al.1998) found that trails altered bird community composition such that habitat edge species (American robins, brown-headed cowbirds, and blue jays) were more abundant near trails. Van der Zande et al. (1984 as cited by Miller et al. 1998) reported a negative relationship between the intensity of recreation occurring on trails and the density for 8 of 13 bird species. Additionally, Van der Zande and Vos (1984, as cited by Miller et al. 1998) found that 11 of the 12 most common bird species exhibited lower numbers in areas where recreation use was more common.

Miller et al. (1998) found that birds were less likely to nest near trails within the grassland ecosystem and that nest predation was greater near trails for both mixed-grass prairie and forest ecosystems. "Reijnen and Foppen (1994) found that in areas where primary song was affected by disturbance, birds there appeared reluctant to establish nesting territories. Gutzwiller et al. (1994) reported that even a single pedestrian moving through a bird's territory was sufficient to reduce the occurrence and consistency of primary song. Because song is an integral component of breeding behavior (e.g., territory defense and mate attraction), it is reasonable to believe that birds sensitive to human disturbance may be reluctant to establish nest sites where human activity is frequent, i.e., near trails (Gutzwiller et al. 1997)" (quotation by Miller et al. 1998). Paton (1994, as cited by Miller et al. 1998) reviewed studies investigating the influence of habitat edge on nest predation, and found that 71 percent and 57 percent of the studies reviewed showed elevated levels of predation on artificial and natural nests respectively, near habitat edges.

Miller et al. (1998) recommended that management of natural areas must entail not only proper trail placement, but also recreationist management. Consolidation of trails to certain areas (e.g., edges of forests and grasslands) will reduce fragmentation of large blocks of habitat, maintaining less-disturbed areas for species sensitive to fragmentation. Gabrielsen and Smith (1995) suggested that, because animals show greater flight response to humans moving unpredictably than to humans following a distinct path, permanent trails should be established to reduce the effects of human disturbance.

Camping

Camping and campgrounds can cause changes in habitat, species diversity and abundance. Clevenger and Workman (1977 as cited by Cole and Landres 1995) reported that populations of small mammals in Canyonlands and Arches National Parks, Utah, were appreciably larger in campgrounds as compared to areas of noncamping. The authors attributed this increase to an increased food supply caused by campers. Schmidly and Ditton (1979) cite findings of a "higher preponderance of juvenile individuals" in a campground population of Peromyscus, seemingly due to lack of predators displaced by human presence.

In Arizona, Aitchison (1977) found that breeding bird densities were similar between a campground (when closed to campers) and a relatively natural area; however, bird species composition differed between sites, the campground having relatively heavier bodied bird species. Once the campground was opened for human use, the breeding bird population decreased in density and diversity, while on the natural site, the bird population remained the same. Boyle and Samson (1985) cited studies (Garton et al. 1977 and Guth 1978) which reported avian species found in campgrounds were "mostly common and widespread species" and the areas were lacking the more rare species found in nearby control areas. Blakesly and Reese (1988) found that avian populations were affected seemingly due to availability of nesting cover and foraging habitat (e.g., local species not using campgrounds seemed to be ground or shrub nesters, and ground foragers). The authors contend these findings could be used when designing riparian campgrounds.

Vegetation is impacted in a similar manner to those described earlier with respect to hiking. Impacts can vary significantly among plant species (Cole 1995). Forbs, shrubs and trees are far less resistant to trampling and are sometimes eliminated (McEwen and Tocher 1976). Soil compaction occurs in areas used for camping, resulting in reduced vegetative reproduction and pioneering of species (Liddle 1975). Use of a campsite as infrequently as one night per year is sufficient to cause measurable impacts in many vegetation types, but usually results in height reduction rather than cover loss. The amount of impact generally increases with an increase of use, but not proportionally. Four times the amount of use did not result in four times the amount of cover and height reduction (Cole 1995). Marion and Cole (1996) suggested that a management strategy could be employed to temporarily close highly impacted sites, but the authors caution that even though vegetation cover in their study area (Delaware Water Gap Recreation Area, in Pennsylvania and New Jersey) "rapidly returned to pre-disturbance levels, species composition remained divergent from pre-disturbance conditions six years after closure."

Visitors often spend more time at their campsite than anywhere else during their visit which can potentially result in a source of pollution (Hendee et al. 1990). Bacterial contamination can be estimated by evaluating the densities of fecal coliforms (indicators of fecal contamination) and fecal streptococci (found in warm-blooded organisms - including humans). From May through July 1976, fecal coliforms and streptococci concentrations sampled during the weekdays were usually similar in Pyramid Creek, located outside of Seattle, Washington, (Christensen et al. 1978). During the weekends, densities remained fairly low upstream, but increased in the downstream samples indicating that an increase in periods of greater human use. All pollutants resulting from recreational use may exhibit a "ripple effect" reaching far into the ecosystem.

In a 1989 survey conducted by the Service, 101 of 478 (21 percent) refuge units allowed camping (U.S. Fish and Wildlife Service 1990). In one (1 percent) case where the Service had legal authority to control camping (n=90), camping was considered incompatible with the purpose of the refuge. On 11 refuge units (11 percent) camping was considered harmful to wildlife (U.S. Fish and Wildlife Service 1990).

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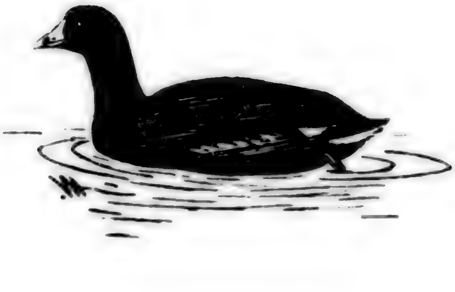
APPENDIX M:

Literature Review: An Assessment of Beneficial and Adverse Impacts of Livestock Grazing to Fish, Wildlife, Plants, and Their Habitat on Stillwater NWR Complex



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LIVESTOCK ON THE STILLWATER NATIONAL WILDLIFE REFUGE COMPLEX: AN ASSESSMENT OF BENEFITS AND ADVERSE IMPACTS

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March 2000

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INTRODUCTION

This report provides an assessment of the positive and negative effects of livestock herbivory on native plant and animal communities in Stillwater National Wildlife Refuge (NWR), Stillwater Wildlife Management Area (WMA), and Fallon NWR, and provides an evaluation of the potential use of livestock toward accomplishing the purposes of Stillwater NWR and Fallon NWR (purposes of Stillwater WMA are not addressed because the designation will cease to exist after November 1998). It is not a comprehensive review of the subject, although I attempted to provide representative examples of differing philosophies on the subject.

U.S. Fish and Wildlife Service (Service) policy directs that livestock grazing, as a management practice, may be permitted on a national wildlife refuge when it enhances, supports, and contributes to established wildlife management objectives (USFWS 1982:6 RM 9.1). It can also be permitted on a refuge if it is determined to be compatible with the purposes for which the refuge was established. A compatible use is defined as one that does not measurably detract from or interfere with achieving the purposes for which the refuge was established, as defined in the National Wildlife Refuge System Administration Act of 1966, as amended. This act requires that a compatibility determination must be completed before any recreational or other use occurs on a national wildlife refuge, and that the determination be based on available scientific information, among other factors. The Service is not required to independently generate any data to assess compatibility of uses. This report represents an assessment of available scientific information pertinent to the effects of livestock grazing on Stillwater and Fallon NWRs, including beneficial effects.

Comments received from the public during the scoping process for the Stillwater NWR Complex comprehensive conservation plan have ranged from the assessment that livestock grazing is needed to provide high-quality wildlife habitat to the argument that livestock should be removed from the refuge because they degrade wildlife habitat. This report explores the various positions and was prepared in an attempt to provide an objective analysis of the issue using published scientific information and other information pertaining to the Stillwater NWR area.

Two livestock-grazing tours were conducted in which the Service received input from a variety of interest groups and professionals. The first meeting, conducted on July 7 and 8, 1997, was a review of the habitat management program by the Regional Office, Portland. Several professionals with expertise in rangeland and riparian systems (from the Agricultural Research Service and the University of Nevada-Reno) were invited to provide technical input. A report was produced by the Division of Operations Support, Regional Office that outlined recommended changes to the habitat management program of the Stillwater NWR Complex (Paveglio et al. 1997).

In the second meeting, July 19, 1997, other professionals and people representing livestock grazing interests and environmental interests were invited to attend the meeting. Participants included representatives from the Natural Resource Conservation Service, the Nevada Chapter of the Society for Range Management, Nevada Chapter of The Wildlife Society, Nevada Wildlife Federation, Great Basin Chapter of Sierra Club, and a private citizen. Several areas on Stillwater WMA, Fallon NWR, and Stillwater NWR were visited during the tour, and participants were asked to provide input on the livestock grazing issue.

Management Perspectives

Livestock Grazing as a Tool to Achieve Refuge Purposes and Goals

Whether a particular management tool is appropriate on a given refuge or other management area depends, among other factors, on desired conditions of the refuge, which is dictated by refuge purposes and other legal authorities. Purposes of Stillwater NWR and Fallon NWR have been stepped-down to proposed goals, and thus, these goals reflect the same desired conditions as the purposes and other legal mandates.

Draft goals of Stillwater NWR, which closely reflect the purposes of the refuge, are to (A) conserve and manage fish, wildlife, and their habitat to restore and maintain natural biological diversity; (B) fulfill international treaty obligations and international agreements with respect to fish and wildlife; and (C) provide opportunities for scientific research, environmental education, and wildlife-dependent recreation that are compatible with refuge purposes. Draft goals of Fallon NWR are to: (A) provide high-quality sanctuary and breeding habitat for migratory birds; (B) restore and maintain natural biological diversity; and (C) provide opportunities for wildlife-dependent recreation that are compatible with refuge purposes. Goals of Fallon NWR would only be adopted under Alternative A (No Action Alternative) and Alternative B of the EIS being prepared for Stillwater NWR Complex's comprehensive conservation plan. Because the area within Fallon NWR would be managed according to the purposes and goals of Stillwater NWR if it were to be incorporated into Stillwater NWR as part of the Stillwater NWR boundary revision, livestock grazing in this area is evaluated under both sets of goals. Furthermore, because the philosophy that Stillwater NWR should be managed primarily to benefit waterfowl has relatively strong support and because this has been the focus in the past, the potential use of livestock grazing as a management tool will also be evaluated against this philosophy.

Thus, one of the major questions addressed in this report is, "can livestock be used to effectively accomplish goals of Stillwater NWR and Fallon NWR under the existing ecological conditions of the refuges?" Whether livestock can be used to enhance wildlife habitat in a particular area depends primarily on (1) the wildlife management goals and objectives of the area; (2) environmental conditions of the area, especially those that influence plant growth and affect livestock distribution; (3) ecological health of soils and vegetation in the area; and (4) class of livestock being considered. Other factors that a manager should consider in determining whether livestock should be used to reach wildlife management objectives include limiting factors of targeted wildlife populations or communities, juxtaposition of habitats (relative to the extent to which livestock would remain in targeted habitats), the ecological processes with which native plant and animal communities evolved, impacts on habitat and non-target wildlife (i.e., side-effects), livestock distribution relative to distribution of target wildlife species, economic feasibility of using livestock to meet specific wildlife objectives relative to other options, availability of the required class of livestock, facilities and personnel needed to maintain adequate control over livestock, and the impacts of these facilities or activities on wildlife.

Ecological Perspective

Given the purposes for which Stillwater NWR must be managed (e.g., restoration of natural biological diversity; Public Law 101-618), an assumption of this report is that "Restoring and sustaining native wildlife communities requires that habitat conditions under which they evolved be restored and maintained, which in turn requires the restoration or emulation of the natural processes that maintained these conditions (Noss 1983, Samson and Knopf 1993, Noss and Cooperrider 1994)" (Nevada Chapt. of The Wildl. Soc. 1995). For the purposes of this report, natural ecological conditions in the Carson Desert are those conditions produced by the geologic, evolutionary, and other ecological processes operating in the Carson Desert, aside from human influences. This report also assumes that the variety of biotic processes, including their seasonal and annual variability in rates, levels, and extent is a component of biological diversity (Noss 1990, DeLong 1996, USFWS 1996). Therefore, not only must natural rates of herbivory be viewed as an ecological process leading to natural biological diversity, it is also a component of it.

A major assumption in restoring and maintaining the natural biological diversity on Stillwater and Fallon NWRs with respect to livestock grazing is that plant communities in the Carson Desert did not evolve under a substantial amount of grazing pressure by large ungulates, as is true of the Great Basin in general (Mack and Thompson 1982, Young et al. 1976, Miller et al. 1994). Burkhardt (1996) disputed this assumption as it pertains to the Intermountain West, including the Great Basin, arguing that vegetation of the Intermountain West evolved under the influence of Pleistocene megafauna until they became extinct. He further argued that extinctions were due to humans, and therefore the absence of these large ungulates is unnatural. However, the climate has changed substantially in the Great Basin since the Pleistocene. The gradual loss of relatively mesic plant species of the Pleistocene, due to a drying climate, corresponded with an increase in xeric species (Nowak, et al. 1994). The general trend in the Intermountain West climate during the last 2,000 years has been erratic, but increasing in aridity and an increased proportion of precipitation occurring during the winter (Antevs 1948, Morrison 1964 and Davis 1982 as cited in Miller et al. 1994). Miller et al. (1994) provides a detailed discussion of the climatic changes in Intermountain West

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vegetation during the past 10,000 years. Thus, it appears unlikely that the vegetation communities of the Great Basin today, even if they were in healthy condition, could sustain the Pleistocene megafauna. This is especially true in lower elevation areas such as the Carson Desert which only receives an average of 5 inches of precipitation per year. The hypothesis that humans caused the extinction of Pleistocene megafauna is receiving serious scrutiny (S. D. Livingston, Desert Research Institute, pers. comm., 1998).

The conclusion here is not that grazing, or herbivory in general, did not play an important role in the ecology of the Carson Desert and associated wetland ecosystem. It is quite possible that, the smaller herbivores, due to their large numbers, may have had a more substantial impact on the Intermountain West ecosystem than the large animals (Miller et al. 1994). In addition to native hoofed animals, there are many other herbivores that can have considerable impacts on plant community structure and composition: small rodents, lagomorphs (rabbits and hares), birds, insects, mites, and plant-parasitic nematodes (Young et al. 1979, Archer and Smeins 1991, Miller et al. 1994). For instance, in Stillwater Marsh, muskrats likely played a prominent role in vegetation structure. The effects that these herbivores have on vegetation communities, as well as those of native ungulates, can be much different than the effects of grazing by domestic livestock (Savory 1988, Stuth Smeins 1991).

Wildlife are a product of their habitat. Because processes shape habitat and habitat management essentially is the management of processes (Luken 1990), the principle that wildlife are a product of their habitat can be expanded to include the assessment that wildlife are a product of processes that shape habitat, including habitat management practices. This principle is important because it influences decisions on the type of vegetation manipulation practices that would be needed to produce the type of habitats that are identified in Refuge goals and objectives. For instance, a natural diversity of wildlife would result in part from the approximation of natural habitat conditions, which are created and maintained by allowing for or mimicking the natural functioning of ecological processes (Noss and Cooperider 1994). Therefore, because the approximation of natural habitat conditions is a focus of Stillwater NWR management, livestock grazing as a habitat management tool must be evaluated in the context of the processes that created and maintained natural habitat conditions of the Lahontan Valley.

In order to evaluate the usefulness of habitat management methods for accomplishing Refuge goals, we needed to understand the processes that created habitat conditions under which native wildlife communities evolved. Of primary concern are the processes of succession, soil erosion, soil formation, and disturbances such as fire, herbivory, and mechanical disturbance (including hoof action). Although uncontrollable, climatic conditions also are important. In particular, hydrology historically influenced vegetation to a large degree in the Lahontan Valley (Appendix F), whereas grazing by large herbivores played a limited role in influencing habitat conditions prior to the introduction of domestic livestock (based on Mack and Thompson 1982; and Young et al. 1976). These two processes are noteworthy because they are two of the primary habitat management practices being evaluated in this Draft EIS, and because significant alteration of water flows and introduction of livestock has had dramatic impacts on vegetation within refuge borders.

1948-1998 Livestock Grazing Program

Livestock grazing in the area of Stillwater WMA prior to 1948 was characterized by Wiseman (1962:3) as follows: "Due to a lack of any grazing control on the affected public lands, the Area was used on a free range basis, with the 'toughest' getting the 'mostest'. Close [severe] grazing was the rule as no one wanted to see any feed 'go to waste'... In the era immediately preceding the leasing of the Area to the Fish and Wildlife Service and the Nevada State Fish and Game Commission, the Truckee-Carson Irrigation District had made an effort to effect some control of the grazing. Truckee-Carson Irrigation District's program to regulate grazing was largely ineffective..."

Since November 26, 1948, livestock grazing on Stillwater WMA, Stillwater NWR, and Fallon NWR has been managed according to direction provided in the Tripartite Agreement that established Stillwater WMA. The Tripartite Agreement is a 50-year agreement between the Truckee-Carson Irrigation District (as contractor of the Newlands Irrigation Project for the U.S. Bureau of Reclamation), Nevada State Board of Game Commissioners (now the Nevada Division of Wildlife), and the U.S. Fish and Wildlife Service. The agreement stated that livestock grazing would be managed "commensurate" with the primary purposes of the area, which were to conserve and manage wildlife, provide a public hunting area, and to establish and maintain a sanctuary. According to the

Tripartite Agreement, the maximum amount of livestock grazing to be permitted on the area was to be determined annually, "having due regard for the condition of the range, and the wildlife requirements thereon."

The first livestock grazing plan was completed in 1951 by D. Marshall (Marshall 1951). He classified livestock grazing into 3 types: desert, marsh, and irrigated pasture. Saltgrass was identified as the most important forage species, but Marshall also noted that rushes and cattail received heavy use in the spring. Marshall argued that spring grazing by livestock was needed to maintain Stillwater Marsh's status as a nesting area. In 1951, the Service anticipated developing about 3,000 acres of irrigated pasture.

Marshall noted that, even in the best of years, much of the "desert" is too far from water to provide grazing opportunities, and that forage production in accessible areas is poor. Thus the desert area "offers little more than supplemental grazing" (Marshall 1951:1). In developing the 1951 livestock grazing plan, Marshall assumed that "With the possible exception of the Stillwater Marsh, heavy grazing does not seem to be detrimental to wildlife. Grazing can not hurt the desert" (Marshall 1951:1).

Marshall recommended two grazing periods for Stillwater WMA exclusive of Stillwater Marsh: April 1 - October 31 (4,500 AUMs) and November 1 - March 31 (1,300 AUMs). The grazing period identified for Stillwater Marsh was April 1 - October 31 (400 AUMs during April 1 - July 15, and 800 AUMs during July 16 - October 31). He also recommended that Indian Lakes, Pelican Island marsh, and Stillwater Marsh be fenced separately. According to Marshall (1951), there were 50 separate operators. Livestock grazing permits were first issued by the Service in 1952 (Wiseman 1962).

A range survey was completed in 1955 (Rouse 1955). The focus of the *Range Survey Report* was on the estimation of the grazing capacity of Stillwater WMA, including Stillwater NWR and Fallon NWR. Rouse divided Stillwater WMA into 20 units, mostly in Stillwater Marsh, for the purposes of his study. In total, he estimated the grazing capacity at 4,150 AUMs for Federal lands in what is now Stillwater NWR, Stillwater WMA, and Fallon NWR. This compares to about 11,000 to nearly 18,000 AUMs year of livestock grazing use during 1957-1961 (which appears to have been about the same amount of grazing use that occurred at the time Rouse conducted his survey). According to Rouse (1955), there were 19 livestock grazing permittees using Stillwater WMA in 1955. In his concluding remarks, Rouse (1955:29), surmised that "While the permitted use of the entire Management Area is greater than the estimated grazing capacity obtained by this survey, it is not believed necessary to make any reductions in the numbers of livestock at this time." and that "The marsh does not show indications of over-use." However, he did note that "The upland forage areas have been over-used for many years and the more palatable grasses have largely disappeared."

Rouse stressed that dividing the area into livestock grazing units was needed to properly control and manage livestock. He surmised that "Under present conditions, management of livestock use on the area is handicapped by lack of controls" (Rouse 1955:30). Despite his repeated references to additional fencing, he concluded that "Fences to enclose [the Pauite Management Unit] would then be justified. The balance of the Management Area, as can be foreseen at this time, would not derive sufficient benefit from the control of livestock to justify fencing that would be required," likely basing this assessment on the capacity of the entire 163,072-acre area being a mere 4,150 AUMs/year. Another of Rouse's recommendations was the construction of several short canals and other water-control facilities for spreading water to increase forage production. He noted that these "improvements" would also increase waterfowl habitat. Rouse also recommended delaying spring turn-out to May 15 in upland areas supporting ricegrass and other bunchgrasses, but noted that "Local graziers may object to holding their stock until this late as they usually do not have sufficient spring pasture to carry them from the end of the feeding period until they can turn them out on the range." Spring turn-out continues to be about April 1.

In 1960, a working agreement was signed by the Nevada State Board of Game Commissioners (now Nevada Division of Wildlife) and the U.S. Bureau of Sport Fisheries and Wildlife (now the Service). Under the agreement, the area now within Stillwater NWR (Area 1) was to be "developed and managed primarily for wildlife with collateral benefits for grazing." Conversely, it was agreed that the area now within Stillwater WMA and the south end of Fallon NWR (Area 2) was to be "developed for grazing by water spreading with collateral benefits for wildlife." It further stated that "During the spring and early summer priority on water use will be given to the management of the entire area for the production of waterfowl and waterfowl food, and for irrigation of pasture."

Because the 1962 Economic Use Plan provided the most detail on the livestock grazing program, integrating information from Marshall (1951) and Rouse (1955), and because it was the last plan written for the area on livestock grazing management, it is summarized at some length. The 1987 Management Plan for Stillwater WMA only minimally addressed livestock grazing.

A revised livestock grazing plan (*Stillwater Wildlife Management Area Economic Use Plan*) was completed in November 1962 (G. Wiseman 1962). One of the key elements of the plan was the maintenance and further development of irrigated pastures. Wiseman noted that the Service and the then Nevada Fish and Game Commission had spent about $250,000 on intensively developing about 2,500 acres of irrigated land (East Pasture, Paiute Pasture, and West Pasture). Apparently, full utilization of these pastures was limited by insufficient water, for which he blamed the Truckee-Carson Irrigation District for demonstrating "poor faith" (under the Tripartite Agreement) with respect to delivering water to the pastures and negotiating for water rights for them. Wiseman suggested that the purchase of water rights for irrigating pastures was essential to maintaining Stillwater WMA for waterfowl management.

Whereas Wiseman (1962) noted additional fences that had been constructed since Rouse's (1955) report, he stated that additional fencing was needed to improve livestock grazing management on portions of the area (i.e., to provide for "proper utilization"). However, he assessed that an extensive program to cross fence the marsh and other parts of Stillwater WMA did not appear feasible given the unreliable water supply.

This paragraph and the following three paragraphs summarize material from the 1962 Economic Plan that portrays further the philosophies of livestock grazing management on Stillwater WMA. With respect to setting year-to-year stocking limits, Wiseman (1962:13) stated that it had become established policy to recognize the need of each permittees for a given amount of grazing use each and every year, and that this "policy" would be followed to the extent that it is possible to correlate individual needs with available forage. In recognition of fluctuations in forage availability from year-to-year, the Economic Plan specified that permit allotments may be increased in years of "feed abundance." Conversely, no provisions were specified to reduce grazing use during drought years, except that the Service would "encourage" voluntary reductions by permittees and would take advantage of attrition of former unrenewed permits when this corresponded to drought conditions.

Wiseman (1962:15) noted that "Historically, the Area has been utilized for grazing year around, with most use occurring from April 1 to November 30. As a measure to support the existing economy, this historic pattern of use has continued under administration by [the Service]." He continued by asserting that "It shall be continuing policy to allow year around use on the native range areas. On seeded and irrigated pastures period of use shall be May 1 to October 31 inclusive." Aside from a different use period on pastures, this practice continues today.

Continued "close use" by livestock and minimal efforts to control livestock grazing, aside from non-renewal of expired permits, may be in part due to the assumption that the main forage species were highly resistant to livestock grazing pressure. For example, Wiseman (1962:14) presented the following conclusions based on "consultation with local and national range authorities, together with personal observations." He surmised that the "primary forage species in the area are almost totally immune to adverse effects resulting from cattle grazing use... Annual plants support a large percent of the grazing load when local precipitation makes these available. Obviously, these annual plants, mainly Russian thistle and alkali weed, are not subject to any adverse effects from grazing."

Wiseman (1962:14) recognized that there were several native species of plants that are adversely impacted by "close grazing use." However, he concluded that "it seems obvious that it is not feasible to regulate grazing to favor a few scattered plants of Indian ricegrass or spiny hopsage, which might show more vigor under lighter stocking rate. In this desert region the impracticality of this is obvious." He further noted that it is imperative to regulate livestock grazing so that it is compatible with waterfowl management. To this end, Wiseman state that "Grazing use shall be maintained at a level designed to benefit waterfowl by creating open shoreline situations, but shall not be pursued to the extent that excessive competition for food and cover occurs." Nothing was said about the relationship between season-long close grazing use and quality of waterfowl nesting cover.

Based on operating experience, Wiseman prescribed the maximum annual stocking limit at 24,000 AUMs for Stillwater WMA. This included unfenced lands to the south (Ole's Pond and S-Line Reservoir, which were

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operated as one unit with Indian Lakes. It also assumed irrigation of East Pastures and Paiute Pastures. In setting this maximum level, nothing was said of Rouse's range survey that indicated the grazing capacity to be just over 4,000 AUMs for roughly the same area. In the "Grazing Management Objectives" section, objectives were expressed in terms of facilitating and increasing forage potential in irrigated pastures. Livestock grazing objectives for the remainder of Stillwater WMA were to: (1) gain more control over livestock grazing through additional fencing, (2) increase permittee's interest in range improvements, and (3) decrease the downsides of community grazing (e.g., permittee bickering, cattle rustling, unnecessary hazing of cattle, among other examples listed). The 1962 Economic Plan did not identify any objectives in terms of range condition (i.e., "...having due regard for the condition of the range, and the wildlife requirements thereon" as stated in the Tripartite Agreement) or to ensure compatibility with waterfowl management.

Wiseman (1962) reported on several artesian wells that provide stock water. Three artesian wells at the delta of the Carson River (on Fallon NWR) were developed in the 1930s as a drought relief measure. Other artesian wells exist: (1) at the north end of Timber Lake, (2) between Cottonwood and East Lakes, and (3) near the Carson River near Papoose Lake. Understandably, salting was ruled out as a practice to increase livestock distribution due to naturally occurring salt deposits and salts associated with forage in the area.

Just as pre-1948 efforts of the Truckee-Carson Irrigation District to control grazing in the area of Stillwater WMA may have been ineffective (Wiseman 1962), it does not appear that the Service has faired much better, except that livestock use of the area has declined over the years. "Close grazing use," "over-use of upland areas," "disappearance of the more palatable grasses," and "lack of livestock grazing management controls [i.e., fencing]," characteristic of pre-Stillwater-WMA-establishment, and the 1950s and early 1960s (Rouse 1955, Wiseman 1962) continue despite a drop in livestock use of the area. Nearly year-long grazing also characterize the existing livestock grazing program. Declining forage consumption by livestock on Stillwater WMA has been due to permits not being reissued as permits are retired and permittees not using their entire allocations. Until the late 1980s, livestock use remained at relatively high levels (e.g., 9,000-11,000 AUMs). In recent years, livestock grazing use has been about half of what it was during the 1950s. It totaled 6,843, 6,531, 6,879, and 7,323 AUMs in 1994, 1995, 1996, and 1997, respectively. Even with these reductions, this amount of use is above the maximum amount recommended by Rouse in 1955.

EFFECTS OF LIVESTOCK GRAZING ON STILLWATER NWR COMPLEX

Livestock grazing effects on native wildlife and vegetation of the Stillwater area range from beneficial to detrimental. An important factor that must be considered in evaluating the effects of livestock grazing on a given ecosystem is the goals of the area. Under one set of goals, the effects of a certain livestock grazing program could be beneficial by contributing toward achieving the goals. The same livestock grazing program, under a different set of goals, could be deleterious by hindering or diminishing the ability to achieve the goals. This factor is especially pertinent to the Stillwater NWR Complex given the shift in management purposes required by Public Law 101-618.

WILDLIFE

Most effects of livestock grazing on wildlife take place through livestock grazing's effects on wildlife habitat. However, direct impacts of livestock on wildlife do occur. For example, some species of birds (e.g., cattle egrets, ring-billed gulls) are attracted to cattle activity, capturing insects stirred by cattle moving about. Inadvertent trampling of nests by livestock has been documented (Gjersing 1971, Koerth et al. 1983), although not thought to be a major factor affecting nest success. Livestock displacement of mule deer has been reported in habitats such as riparian areas (Rule 1989, Kie et al. 1991). Holechek et al. (1995:362) noted that social aversion to livestock by mule deer may be of minor importance at light or moderate stocking rates.

Aside from effects on habitat, potentially the greatest direct impact of a livestock grazing program on wildlife is the fences used to control livestock. Location and design of fences influences magnitude of impact (Spillett et al. 1967, Kindschy et al. 1982). Potential impacts of fences on wildlife are probably highest in riparian and emergent marsh habitats, where wildlife activities are concentrated (Thomas et al. 1979, Maser et al. 1984a) and where the need for fencing to control livestock distribution traditionally is greatest (Platts 1989). Some of the wildlife known to have

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been killed by hitting fences include pelicans, herons, egrets, coots, and waterfowl (Annual Narrative Reports, Refuge files).

WATER QUALITY

Livestock use in uplands can affect water quality directly by increasing sediment loading and coliform bacteria counts in overland runoff, and indirectly through the impacts they have on vegetation (Blaisdell et al. 1982, Minshall et al. 1989). Sediment loading can increase through increased soil disturbance and disruption of mycrophytic crusts (St. Clair et al. 1993). Livestock can reduce water quality by trampling banks and defecating in streams (Dunne and Leopold 1978:740, Platts and Nelson 1985). Indirect effects of prescribed burning, haying and livestock grazing on water quality relate to the extent to which they influence vegetation attributes. Changes in vegetation leading to increased sedimentation can decrease water quality of streams (Platts and Nelson 1985, Clary and Webster 1989, Minshall et al. 1989).

SOIL

Riverine-riparian, Marsh Shoreline, and Meadow

Direct impacts of livestock grazing on soils can include trampling of streambanks and reduction of infiltration rates from soil compaction. Damage to streambanks is reported where banks have been de-stabilized by excessive livestock use (Clary and Webster 1989, Armour et al. 1991). The probability of damage to streambanks from livestock use is related to several factors including: (1) characteristics of streambanks and adjacent stream channels; (2) type and condition of streambank vegetation; and (3) success of control over the timing, intensity, and duration of livestock use (Clary and Webster 1989, Platts 1989; Myers and Swanson 1991). Streambanks with coarse-textured soils are less prone to damage from livestock use than streambanks with fine-textured soils (Myers and Swanson 1991).

Livestock grazing can indirectly influence soils by changing vegetation vigor and composition. The amount of unstable streambank is related to composition of streambank soils, composition of streambank vegetation, and intensity of livestock use (Clary and Webster 1989, Platts 1989). Intensive use of sites by livestock can increase probability of streambank damage by reducing composition of deep-rooted sedges and willows and increasing composition of shallow-rooted grasses (Kovalchik 1987, Kovalchik and Elmore 1992). Sedges and rushes have been shown to hold stream-side soils better than grass-dominated communities (Dunaway, et al. 1994, Swanson 1996), and sedge species such as Nebraska sedge (*Carex nebrascensis*) appear to have the greatest ability to hold streambank soils intact (Kleinfelder et al. 1992). Increased infiltration rates and decreased soil compaction have been associated with non-use by cattle and a rest-rotation cattle grazing system, as compared to more traditional livestock grazing strategies which appeared to hinder recovery of infiltration and soil compaction (Bohn and Buckhouse 1985). After one year of research, Hayes (1978) reported that rest-rotation cattle grazing in central Idaho did not significantly accelerate channel movement by bank degradation. In other instances, certain rest-rotation practices appear to have allowed riparian areas to begin recovering (Meyers and Swanson 1995, Masters 1996).

Non-structural and structural management practices are used to restore streambanks and channels. Non-structural methods include rest from livestock grazing (Clary and Webster 1989) and increased control over livestock use (Platts 1989, Masters et al. 1996). Although it is well documented that adjustments to livestock grazing programs can reduce adverse impacts to riparian soils and vegetation, and thus allow recovery to occur, these adjustments do not rival the recovery that occurs from completely excluding livestock from riparian corridors (Clary and Webster 1989, Platts 1989, Platts 1990). Structural techniques include planting willow (McCluskey et al. 1983), installation of juniper revetments (Sheeter and Clair 1981), and construction of check-dams (Heede 1966).

Uplands

In general, impacts to upland soils may be limited on the Stillwater area, except on sites where concentrated use has occurred. Disturbance of the soil surface in some vegetation types, especially where mycrophytic crusts occur, can lead to increased soil erosion potential (St. Clair and Johansen 1993, St. Clair et al. 1993). Indirect effects stem primarily from the influence of livestock grazing on ground cover and vegetation composition.

Rest from livestock grazing in upland areas would not result in substantial change in composition of plant communities or soil characteristics where shrub cover is excessive (Winward 1991, Laycock 1991). Higher soil erosion rates and lower water-infiltration rates have been recorded on sites with excessive shrub cover compared to sites with less shrub cover and more ground cover (Blaisdell et al. 1982).

COMPOSITION AND STRUCTURE OF VEGETATION

Riverine-riparian, Marsh Shoreline, and Meadow

Livestock grazing has been a major contributing factor to significantly altered composition and structure of riparian areas, including riparian meadows, throughout the intermountain West (Thomas et al. 1979, Platts et al. 1989, Elmore and Kauffman 1994, Kie et al. 1994, Dobkin et al. 1998). Livestock grazing can reduce the vigor of native vegetation along streambanks (Pond 1961, Knopf and Cannon 1982, Skovlin 1984, Kovalchik and Elmore 1991). When plant vigor of streambank vegetation is consistently reduced, it begins to be replaced by vegetation more resistant of grazing pressure (Pond 1961, Kovalchik and Elmore 1991). Reduced vigor and altered species composition of plant communities can result in increased streambank erosion because of reduced root-mass and binding ability of streambank vegetation in alluvial valleys (Clary and Webster 1989, Gebhardt et al. 1989, Kleinfelder et al. 1992, Dunaway et al. 1994). Consequently, streambanks become less resistant to high water flows, banks erode, the channel-form changes, and water tables drop in alluvial valleys (Van Havereen and Jackson 1986, Gebhardt et al. 1989, Leonard et al. 1992). Lowered water tables contribute further to reduced cover of native riparian vegetation and increased cover of native upland plants (e.g., big sagebrush) that are tolerant of dry soils (Elmore and Beschta 1987) as well as non-native grasses that have limited soil-binding potential (e.g., timothy, cheatgrass). Under these conditions, stream channels continue to erode until a new floodplain becomes established at a lower base level (Van Havereen and Jackson 1986, Gebhardt et al. 1989). No benefits of livestock grazing in riparian areas were identified in the July 1997 Habitat Management Workshop, except for the possible use of sheep in controlling noxious weeds (Paveglio et al. 1997).

Adjustments to livestock grazing practices can allow recovery to begin in riparian areas (Clary and Webster 1989, Meyers and Swanson 1995, Masters et al. 1996). For example, implementation of deferred rotation cattle grazing in central Nevada, following years of season-long cattle grazing, allowed the studied riparian areas to begin recovering. In the study, riparian areas that were completely rested from livestock grazing and absent any roads had the highest recovery rates, followed by riparian areas under a deferred rotation system absent any roads in the riparian area. Riparian and shrub cover increases were highest in the areas where livestock were completely excluded. After three seasons of cattle being excluded from two exclosures in the Carson River floodplain and delta on Stillwater WMA, preliminary observations indicate a considerable increase in plant species diversity (R. Bundy, Stillwater NWR, pers. comm., 1999).

Although livestock grazing has likely contributed toward degradation of the lower Carson River riparian area, significantly altered hydrology in the Stillwater area (Kerley et al. 1993) has been the major factor. Another major factor has been the introduction and spread of invasive plant species such as saltcedar, which . However, continued livestock grazing has the potential to hamper efforts to restore the geomorphology and riparian vegetation of the lower Carson River. By slowing or inhibiting the recovery of native riparian vegetation, livestock grazing would hinder progress toward restoring natural biological diversity, a major purpose of Stillwater NWR (Public Law 101-618, § 206(b)(2)).

On Stillwater WMA and Fallon NWR, reduced vigor of native riparian vegetation has also likely contributed to high densities and canopy cover of saltcedar. Thus, while livestock grazing is not the cause of saltcedar being introduced to the area, it likely has contributed to the significantly altered species composition and structure of plant communities. In the meadow habitat associated with the delta of the Carson River, large portions of the plant community have changed from a mixture of grasses, rushes, forbs, and sedges to domination by saltcedar. Eventually, if left unchecked, saltcedar can form monotypic stands. If factors reducing the vigor of native vegetation (e.g., inadequate water availability; season-long, heavy livestock grazing) are not corrected, expansion of perennial pepperweed (tall white-top) will be also facilitated.

Negative effects to wildlife usually are associated with (1) temporary removal of cover required by species for reproduction and concealment (Kirsch et al. 1978, Medin and Clary 1990, USFWS 1990, Kantrud 1990); and (2) frequent, intensive removal of vegetation that results in long-term alteration of stream channel geomorphology, and, consequently, diminished area of the riparian wetland (Winegar 1977, Thomas et al. 1979, Gebhardt et al. 1989, Schulz and Leninger 1991). With respect to item number 1, above, the "temporary" removal of vegetation occurs for most of the year on Stillwater WMA and Fallon NWR, and thus has resulted in nearly year-round depletion of cover.

The effects of livestock grazing on meadow vegetation were studied along the lower Carson River in Fallon NWR. Near Battleground Point, five sample plots located inside a 1-hectare livestock grazing exclosure and four of five sample plots located outside the exclosure were characterized in April 1997 as a saltgrass dominated plant community with few other species present. From April 1997 to September 1999, sample plots within the exclosure changed to a more native mix of plant species, with a higher diversity of plant species within the community, while the outside sample plots retained the same vegetative composition throughout this period (Table 1) (Bundy and DeLong, U.S. Fish and Wildlife Service, Unpubl. Data). The number of species within plant communities, the average amount of the ground covered by vegetation, and the average height of plants within the sample plots were roughly at the time the livestock grazing exclosures were constructed (2.4/3.6 species, 15%/13% ground cover, and 10cm/12cm average height, for inside plots/outside plots respectively), but, these values had changed to 8.4/4.8 species, 72%/61%, and 44cm/20cm by September 1999. Compositional differences were not as apparent on an exclosure located roughly one mile south of the one near Battleground Point. The southern area had fewer grasses and more shrubs, which would not be expected to change to the same degree over the three year sample period.

Concealment cover near ground level (e.g., up to 6-½ inches) was measured inside and outside the north and south livestock grazing exclosures. Concealment cover was estimated using a 6-½x6-½" cover board divided into 25 squares with 4 dots each (100 points). At the time the exclosures were constructed in April 1997, concealment cover below 6-½ inches was nearly equal between the inside and outside plots for both the northern and southern exclosures (Figure 1). After one growing season, concealment cover remained unchanged outside the livestock grazing exclosure, but increased inside the exclosure at both locations. By the end of the third growing season, concealment cover had more than doubled inside the exclosure, but still had not changed outside the exclosure.

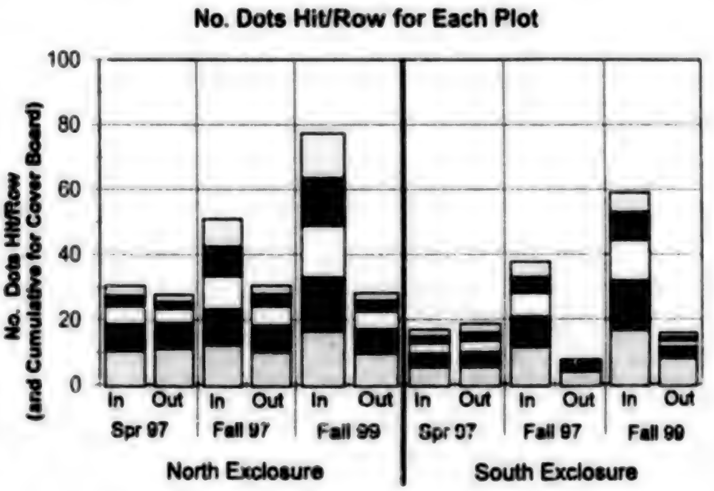

Figure 1. Graph illustrating the difference in concealment cover inside and outside of two livestock exclosures, during three sampling periods following construction of the exclosures (May 1997), Fallon National Wildlife Refuge, Nevada. Each vertical cell in bars represents cover at 1.3 in. height intervals from lowest (bottom) to highest.

Because livestock can alter the vegetative structure of plant communities, increasing it in some cases (Holechek et al. 1995, Severson 1990, and Kie and Loft 1990), they can benefit some species of wildlife. Holechek et al. (1995:357) stated that livestock can be selectively grazed to open up dense stands of vegetation. Kie and Loft (1990) cited several studies that indicate that cattle can be used to create tunnels through shrub vegetation (e.g., willow stands). They also cited two studies that put forth evidence that modifying the structure of shrub stands can benefit some species of wildlife. However, native shrubs (e.g., willows, wild rose, buffalo berry) are nearly absent

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Table 1. Community type (as characterized by Bundy et al. 1996), number of species (SP), total canopy coverage (CC), and average height (HT) for 2 grazing exclosures (north - N, south S) and 20 sample plots (inside - I, outside - O) measured near Fallon NWR, 1997-1999 (Bundy and DeLong In Prep.).

	April 1997				September 1977				September 1999			
PLOT	**Community**	**SP**	**CC**	**HT**	**Community**	**SP**	**CC**	**HT**	**Community**	**SP**	**CC**	**HT**
NI30	Saltgrass	2	16	4	Saltgrass/Mallow	5	48	27.6	Saltgrass/mixed forb	12	78	39.3
NI37	Saltgrass	4	8	15.8	Saltgrass	15	100	28.9	Saltgrass	5	100	54
NI45	Saltgrass	1	10	14	Mixed Meadow Grass	11	74	33.9	Saltgrass/Baitic Rush	8	88	40
NI48	Saltgrass	3	12	9.3	Mixed Meadow Grass	13	86	28.6	Mixed Meadow Grass	13	92	46.2
NI96	Saltgrass	2	31	8.5	Saltgrass/Bassia	3	28	40.3	Saltgrass	4	4	39
NI	Average	2.4	15	10	Average	9.4	67	32	Average	8.4	72	44
NO05	Saltgrass	3	12	5.3	Saltgrass	5	67	11.8	Saltgrass	7	63	18.3
NO11	Saltgrass	2	9	15	Mixed Meadow Grass	2	92	24	Saltgrass	2	96	25
NO49	Saltgrass	2	9	8	Saltgrass	2	17	15	Saltgrass	1	45	14
NO88	Saltgrass	6	17	13	Saltgrass	2	26	28	Saltgrass	4	73	23.8
NO97	Mixed Meadow Grass	5	18	19.8	Mixed Meadow Grass	10	24	12.1	Mixed Meadow Grass	10	29	16.4
NO	Average	3.6	13	12	Average	4.2	45	18	Average	4.8	61	20
SI02	Mixed Meadow Grass	12	46	18.6	Mixed Meadow Grass	11	47	38.4	Saltgrass/Baltic Rush	9	55	49.4
SI18	Mixed Shrub	6	64	42.2	Mixed Shrub	6	49	74.2	Greasewood/Saltgrass	6	83	57.8
SI27	Rabbitbrush/Mixed Forb	17	48	17.9	Rabbitbrush/Mixed Meadow Grass	9	62	53.9	Mixed Meadow Grass	16	85	51.3
SI32	Saltgrass/Bassia	6	50	19.5	Saltgrass/Bassia	4	48	63	Mixed Meadow Grass	5	92	35
SI33	Saltgrass	1	35	13	Saltgrass	2	44	28	Saltgrass	2	71	23.5
SI	Average	8.4	49	22	Average	6.4	50	52	Average	7.6	77	43
SO01	Mixed Meadow Grass	10	69	38.2	Saltgrass	7	28	31.6	Saltgrass	6	55	18.8
SO22	Tamarisk	1	33	22.1	Tamarisk/Mixed Meadow Grass	2	76	37.6	Tamarisk/Saltgrass	2	68	38.4
SO39	Four-wing Saltbush	6	43	33.3	Four-wing Saltbush	5	28	29.2	Four-wing Saltbush	3	26	71
SO48	Mixed Shrub	6	27	46.8	Mixed Shrub	5	43	49	Mixed Shrub/Saltgrass	3	33	59.3
SO62	Mixed Meadow Grass	11	32	18.9	Saltgrass	5	19	28.4	Saltgrass	9	70	27.7
SO	Average	6.8	41	32	Average	4.8	39	35	Average	4.6	50	43

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on the Stillwater area, thus nullifying consideration of this application for many years to come. I am unaware of any documentation of cattle being used to open-up mature stands of saltcedar.

Whereas wildlife species that prefer relatively dense and tall meadow vegetation (graminoid dominated) would be positively impacted by reductions in or elimination of cattle grazing from along the Carson River and meadow areas in Stillwater WMA and Fallon NWR, species that prefer low statured vegetation in meadows could be adversely impacted when vegetation recovers. Height of vegetation in meadow habitat grazed by cattle in Stillwater WMA and Fallon NWR has been far below the 12 inches used by Kie and Loft (1990) as a cut-off between short and tall vegetation in meadows. Characteristic height of herbaceous vegetation along the Carson River and associated meadow habitat in these two areas is 3-6 inches or less.

Given available information, I agree with Kindschy's (1987, as cited in USBLM 1991b) assessment that, "in essence, livestock are NOT 'a tool' to improve riparian ecosystems. Rather, they are a cost that may often be accommodated and still enable successional advancement of riparian vegetation and attendant functional values." Although recovery of many riparian areas can proceed under a carefully managed livestock grazing program, the most effective solution is the exclusion of livestock from riparian areas (Kaufmann and Krueger 1984, Platts 1990, Kovalchik and Elmore 1992, Buckhouse and Elmore 1993, Chaney et al. 1993).

Effects on the Habitat of Specific Groups of Wildlife

Waterfowl, Shorebirds, and Other Waterbirds

Effects of livestock grazing ranges from beneficial to detrimental, depending on the actual grazing practices, condition of the vegetation, desired conditions, and other factors. Species that use meadows, pastures, or shorelines with short vegetation and bare ground (e.g., killdeer, mountain plover) can benefit from livestock grazing, so long as the grazing does not contribute to the conversion of the plant community to saltcedar or other invasive non-native plants.

The Blitzen Valley Management Plan for Malheur NWR (USFWS 1990:143-144), reported that impacts of livestock grazing on breeding waterfowl on the refuge were indirect because cattle were grazed primarily in the fall or winter. The plan listed several benefits of grazing meadows by cattle: (1) habitat diversity and patchiness, (2) increased chances of successful germination of seeds, (3) cattle dung can host invertebrate wildlife which can be used by other wildlife, (4) it can stimulate growth of new vegetation. Only the first benefit was accompanied by a literature citation. Preliminary findings of a study conducted on Malheur NWR (USFWS 1990:144) suggest that meadow areas that were rake-bunch grazed had higher numbers of ducks and geese present on them during April-May as compared to meadow areas that were left idle. However, in another study, excluding grazing and restricting mowing to late summer resulted in ducks nesting earlier and in higher densities of nesting ducks (Clark 1977). When grazing and mowing were excluded, duck production increased.

In general, livestock grazing is detrimental to waterfowl nesting. Kirsch (1969), after reviewing waterfowl literature, suggested that "cover removal such as regular grazing and mowing should be discontinued on areas managed primarily for waterfowl production and that management practices that create dense rank cover be substituted." He recommended that periodic burning or soil disturbance be tested as a means to create dense, rank cover. In reviewing the literature, Kirsch was unable to find a single example of where livestock grazing increased waterfowl production. Strassmann (1987), in reviewing livestock grazing and haying programs of 123 NWRs, concluded that "there is solid evidence that cattle grazing is harmful to all species of ducks that managers believed to benefit from grazing." Braun et al. (1978, as cited by USFWS 1990) reported that at least 55 studies on waterfowl have demonstrated that livestock grazing can be detrimental to waterfowl production and that they knew of only one study that reported higher nest success in areas moderately grazed by livestock compared to idle lands. Holechek et al. (1989:353) noted that grazing by livestock, at even light intensities, appears to be harmful to nesting waterfowl, with some exceptions. Conversely, Marshall (1951) alleged that the highest nesting concentrations on Stillwater WMA occurred in the Indian Lakes, an area of heavy to severe livestock grazing pressure. He surmised that adjoining desert shrub growth provided ample nesting cover. However, this assessment was not accompanied by supportive data. Marshall (1951) identified another benefit of heavy livestock grazing in the Battleground wetland area. According to Marshall, the grazing pressure effectively eliminated waterfowl nesting in the area, which was considered beneficial because the marsh dries quickly and "the broods would die for lack of water."

Kirby et al. (1992) reviewed the literature on the effects of livestock on breeding waterfowl. They found no evidence from appropriately designed studies to indicate that livestock grazing benefits upland nesting ducks. Some circumstantial results from poorly designed experiments suggest the opposite. However, they went on to say that livestock grazing should remain in the manager's tool kit, but that the status of wildlife habitat and refuge objectives must define the need for a particular grazing regime. They also made the assessment that if immediate restoration of riparian habitat is the goal, "no measure would will be as successful as completely excluding livestock." After analyzing 26 years of duck nesting data in relation to livestock grazing and other habitat management practices on Monte Vista NWR, southern Colorado, Gilbert et al. (1996) concluded nest densities consistently were still depressed 3 years after grazing and that nest success declined as grazing intensity increased. Whereas Peek (1986:198) stated that the influence of livestock grazing activities on waterfowl range from positive, to neutral, to detrimental, the only benefit of livestock production that Peek pointed out is the development of stock-watering impoundments in arid regions of the West. This benefit, however, does not pertain to livestock grazing as a process.

In literature reviews on the effects of livestock grazing on wildlife species of interest at Greys Lake NWR, Minidoka NWR, and Camas NWR, Idaho, Bouffard (199?) found that the adverse impacts of livestock grazing generally outweigh any benefits to waterfowl production. In his literature reviews, Bouffard noted that livestock grazing affects upland nesting ducks more than over water nesters, due to the impact livestock have on reducing tall, dense cover in upland areas.

Some of the published papers that describe the benefits of livestock grazing to waterfowl nesting include the following. Holechek et al. (1982, as cited by Strassmann 1987) report that limited burning or grazing every 1-3 years increases blue-winged teal production in Iowa and South Dakota. Sedivec (1990) reported that waterfowl nesting success was higher in grazed areas as compared to non-grazed areas in North Dakota prairie potholes. A study cited by Kirsch (1969) reported higher nesting success of blue-winged teal in moderately grazed areas compared to ungrazed areas. However, Kirsch pointed out that most of the ungrazed areas that contained nests consisted of narrow strips or clumps of idle land, that were later shown to be more vulnerable to predation. Furthermore, Stillwater NWR is outside of the breeding range of blue-winged teal.

Severson (1990), in summarizing a symposium on the use of livestock as a wildlife-habitat management tool, qualified the use of livestock grazing to manage waterfowl habitat by stating that "...it is easier to visualize how livestock could be used to manage vegetation in the Northern Great Plains [in contrast to the American Southwest]. The primary reason is that the vegetation of the Plains evolved under significant grazing pressure by large ungulates; whereas that in the Southwest did not. The logic employed by Kantrud (these proceedings) in his assessment of using prescribed cattle grazing and prescribed fire as replacements for bison and wildfire, to manage waterfowl habitat in the Prairie Pothole region of the Great Plains, is correct for that region. However, the same logic should be cautiously applied to other regions, such as the mountain wetland "cienagas" of the Southwest." Similar to the Southwest, vegetation of the Great Basin did not evolve under a substantial amount of grazing pressure by large ungulates (Mack and Thompson 1982, Young et al. 1976). This is especially applicable to Stillwater NWR given the mandate to restore and maintain natural biological diversity (Public Law 101-618, Subsect. 206(b)(2)).

In cases where maximizing duck production is a major goal, Gilbert et al. (1996) recommended that actions only be taken to reduce residual vegetation when the residual vegetation is "so dense as to insulate the soil and block light penetration, thereby reducing new growth." They noted further that "A long recovery time is needed to restore residual vegetation removed by these actions. On Monte Vista NWR, they estimated through extrapolation that the frequency of vegetation-reduction treatments should be longer than the 3 years practiced in the past on the refuge, perhaps no more than every 6 or 7 years. Removal of residual cover, if needed, could be accomplished using livestock, haying, or prescribed burning. They also recommended taking periodic height-density measurements of vegetation at nest sites and random locations.

With respect to enhancing waterfowl nesting habitat, livestock grazing, prescribed burning, or haying would only be necessary if accumulation of fallen vegetation is adversely impacting new growth of vegetation and reducing the

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quality of duck nesting habitat. Available information suggests that reducing accumulations of dead plant material to rejuvenate waterfowl nesting habitat on Stillwater NWR/WMA and Fallon NWR would not be necessary more than once every 6-7 years. At present, well-irrigated saltgrass communities appear to be the only habitat where dead plant material would accumulate to the point where it would reduce the quality of duck nesting habitat in the Stillwater area. Whether or not herbaceous vegetation should be reduced in a particular area would depend on objectives of the area. Available information indicates that frequent grazing by livestock (every 1-3 years regardless of season of use) would adversely impact duck nesting habitat.

A potential benefit of livestock grazing along shorelines and in meadows is "Closely grazed areas of clover and grasses [on Stillwater WMA] which exposes new growth are eagerly pastured by geese during the fall and spring seasons... (Rouse 1955:3)." Rouse continued by stating that new growth will not be used if it is protected by rank vegetation. Greenwalt (1978, as cited by Strassman 1987) reported that cattle grazing can increase the abundance of edible green shoots in goose feeding areas. USFWS (1992d) cited another example in which moderate livestock grazing was used to create feeding habitat for wintering waterfowl.

Riparian Birds

Livestock grazing has generally been shown to adversely affect riparian bird species richness and abundance, resulting from loss of foraging and nesting cover, direct disturbance of low nesting birds, soil compaction, lowering of water tables, and depletion of mature stands of shrubs and trees by long-term attrition (Mosconi and Hutto 1981, Bull and Skovlin 1982, Taylor 1986, Taylor and Littlefield 1986). As explained by Knopf (1996), livestock grazing can have major, relatively immediate impacts on shrub and ground vegetation layers, whereas impacts to birds nesting in tree canopies, if they result from livestock grazing, are not immediate. However, Knopf did not address the immediate impacts of canopy nesters that also require shrub and ground cover. Populations of species dependent on tall grasses to conceal their nests decline locally while the densities and numbers of birds that favor shorter herbaceous vegetation and as livestock grazing pressure increases (Knopf 1996). Knopf also noted that, in addition to affecting vertical structure of vegetation, livestock grazing can also change the horizontal pattern of vegetation layers by creating more open shrub stands (Knopf et al. 1988, as cited by Knopf 1996).

Sanders and Edge (1998) reported significant differences in the abundance of bird species among different structural stages of willow communities in eastern Oregon. Total abundance of birds was highest in continuous riparian shrub associations, as compared to discontinuous and herbaceous xeric shrub associations. In a riparian meadow habitat in southeastern Oregon, Dobkin et al. (1998) reported marked differences between bird communities in a nearly recovered wet meadow community (characterized as a "dense, sedge-dominated community") and nearby degraded portions of the meadow (sparsely vegetated with minor sedge component and high density of xeric shrubs). The nearly recovered wet meadow community had been rested from livestock grazing for 30 years and other parts, above and below, had been grazed up until the initiation of the study.

Ryder (1980, as cited by Knopf 1996) pointed out that species such as mountain plovers and horned larks increase and species such as meadow larks decline in response to increasing intensities of livestock grazing pressure on the Great Plains (only listed here were those species found in the Stillwater area). However, a species that increases in one local due to heavy livestock grazing may respond differently in a different location; the effect of livestock grazing on any given species depends on the effects that grazing has on its habitat. Whereas American robins and northern flickers were found to be more abundant in riparian areas being grazed by cattle in Montana and Colorado (Mosconi and Hutto 1982, Schultz and Leininger 1991, as cited by Knopf 1996), these species decline in response to livestock grazing when aspen are unable to regenerate due to grazing.

Knopf (1996) argued that the season of livestock grazing is a more important consideration than intensity of grazing. He cited several examples whereby the effects of livestock grazing were reduced by delaying grazing to late in the growing season or when vegetation was dormant. Grazing when the vegetation is dormant apparently has less impacts on bird communities because it has less impacts to the vegetation. Regardless, however, low residual herbaceous cover lasting the remainder of the year into the following nesting season would affect the diversity of ground-dwelling and nesting birds associated with dense herbaceous vegetation based on other studies cited by Knopf (1996) and others. Two of the studies cited by Knopf (1996), Sedgewick and Knopf (1987) and Knopft et al. (1988), reported no significant difference between late-season grazed and ungrazed areas in terms of population

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parameters of common, widespread species of birds associated with riparian habitat. Care should be taken in interpreting these results, as the conclusions of these studies only demonstrated that adverse impacts were not detected with respect to the parameters measured, as opposed to demonstrating that there were no impacts at all.

Although riparian areas have the potential to support the most diverse communities of birds on the Stillwater area, the species composition and population numbers of these riparian bird communities typify heavily disturbed, rather than healthy, riparian habitats of the Lahontan Valley. For instance, only a relatively small number of common, widespread species (e.g., American robin, red-winged blackbird, and house wrens) typically are found along the Carson River within the Stillwater WMA and Fallon NWR. Conversely, species requiring gallery stands of mature cottonwoods (e.g., yellow-billed cuckoo) and dense undergrowth or canopy of riparian shrubs (e.g., yellow-breasted chat) are rare or absent (Robert Flores, U.S. Fish and Wildl. Serv., pers. comm., 1998). On the lower Truckee River, about 50 miles away, species requiring dense understory of woody riparian vegetation that were common or abundant in 1868 were less common or absent in similar counts made in 1972, 1975, 1976, 1980, and 1981 (Klebenow and Oakleaf 1984). According to the authors of the study, "Shrub and thicket inhabitants that were completely missing from the recent surveys included the Yellow-billed cuckoo, Black-chinned hummingbird, Willow flycatcher, and Yellow-breasted chat (Klebenow and Oakleaf 1984:207). Whereas conversion to farmland and river-channel alterations were likely the major factors that adversely impacted riparian vegetation, severe livestock grazing was reported as a contributing factor.

Similarly, the dominant factor causing the degradation of the lower Carson River and Stillwater Slough is the significantly altered hydrology. However, season-long, heavy cattle grazing appears to be a contributing factor. Continued cattle grazing along the lower river would hamper restoration of the riparian habitat by limiting recruitment of cottonwoods and willows, impairing recovery of graminoids, maintaining low height of herbaceous vegetation, contributing to increased composition of invasive plant species, and trampling streambanks, as discussed previously.

Small Mammals of Riparian Areas and Meadows

Studies indicate that small mammal composition and abundance is influenced not only by the amount of riparian habitat (Brown 1978), but also by the height and density of cover resources within and among riparian and emergent wetlands (Cornely et al. 1983, Schulz and Leninger 1991). Reduction in height and density of herbaceous vegetation reduces diversity of small mammals in riparian and emergent wetlands (Kauffman et al. 1982, Medin and Clary 1989, 1990). Based on published impacts to small mammal populations, Bouffard (199?) concluded that livestock grazing can adversely impact raptors that feed on small mammals.

In the Lahontan Valley, riparian, shoreline, and meadows are the primary habitat of several small mammals species including vagrant shrew, western jumping mouse, montane vole, long-tailed vole, valley pocket gopher (Charlet, et al. 1997). Whereas shrews, jumping mice, and voles are sensitive to reduction of cover height and density, other species like pocket gophers are tolerant of reduction in cover height and density (Hanley and Page 1981, Cornely et al. 1983, Kauffman et al. 1982, Jenkins and Eshelman 1984, Maser et al. 1984b, Medin and Clary 1989, 1990, Schulz and Leninger 1991). However, all species are adversely affected by land-use practices that reduce the area composed of wetland habitat, which can result from improper road design, mismanagement of livestock, and other factors (Winegar 1977, Gebhardt et al. 1989, Kovalchik and Elmore 1992, Leonard et al. 1992). Charlet et al. (1997) surmised that maintenance, and more so the recovery of the riparian corridor in Stillwater WMA would be needed to enhance the continued existence of desert woodrat population and could potentially attract bushy-tailed woodrats. In addition to sagebrush, tall grass was listed as an important factor for maintaining healthy woodrat populations.

Using the computerized California Wildlife Habitat Relationships (WHR) database, Kie and Loft (1990) predicted the effects of livestock grazing on vertebrate wildlife species in two structural conditions (short-herb and tall-herb) for annual grassland habitat and for wet meadow habitat. They assumed that the arbitrary height category of less than 12 inches (short-herb) to be characteristic of a grazed area and greater than 12 inches (tall-herb) to be characteristic of a non-grazed area for each of the two habitats. The database predicted that reduced herbaceous height to less than 12 inches (from a height of greater than 12 inches) would positively affect 52 species, neutrally affect 171 species, and negatively affect 19 species in California annual grassland communities. In California wet

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meadow communities, the database predicted that reducing herbaceous height to less than 12 inches would positively affect 59 species, negatively affect 37 species, and have no effect on 169 species. Kie and Loft (1990) warned that their results should only be used as a first approximation, and that the outputs require close scrutiny for potential errors. The authors pointed out where the database listed two small mammals (montane vole and western harvest mouse) as being positively affected by reduced vegetation height, when they actually would be adversely affected by most livestock grazing systems.

Natural Operation of Biotic Processes

The variety of biotic processes is a component of biological diversity (Noss 1990, DeLong 1996, U.S. Fish and Wildl. Serv. 1996). Some of the biotic process operating in riparian, shoreline, and meadow areas are herbivory, succession, predation, immigration, and emigration of species.

Although herbivory is a natural ecological process in the Stillwater area, as it is in all ecosystems containing vegetation, the process of herbivory by livestock does not necessarily mimic natural herbivory rates. Possibly the only ungulate to occupy the Stillwater area in any numbers or with any regularity is the mule deer, although bighorn sheep and pronghorn occasionally wandered through the area, as possibly did an occasional elk or bison. Mule deer likely inhabited the riparian corridors associated with the Carson River and its abandoned channels. Other herbivors in riparian corridors and floodplain meadows likely included mountain cottontails, montane voles, other rodents, and a large variety of insects and other invertebrates. Although no references were found, several species of invertebrates would have grazed vegetation in the Carson River. As with most other areas throughout the Intermountain West (Miller et al. 1994), the introduction of livestock in the mid and late 1800s brought with it a significant increase in grazing and browsing pressure on plant communities throughout this area. I am unaware of any information suggesting that natural herbivory rates by mule deer, cottontails, voles, and other native herbivores would not occur given sufficient recovery of riparian and other habitats and response by these species.

Livestock herbivory can speed or slow vegetative succession, depending on the plant community, its current seral stage, among other factors (Gifford 1976, Archer and Smeins 1991, Pieper 1994). It can also affect the direction of succession (Kovalchik and Elmore 1991). For example, to the extent that livestock herbivory pressure inhibits recruitment of cottonwoods, willows, and other native riparian woody vegetation, it slows succession and may result in succession proceeding toward a more xeric shrub community or saltcedar community rather than a mature stand of native riparian woody vegetation. Similarly, heavy to severe livestock grazing on Stillwater WMA (Rouse 1955, Wiseman 1962), likely has contributed to meadow communities succeeding toward mature stands of non-native mesic woody vegetation (e.g., saltcedar) in areas not naturally supporting woody vegetation. The significant alterations in Carson Desert wetland hydrology (Kerley et al. 1993) is likely a more important factor contributing to more xeric conditions in riparian zones in the Stillwater area.

As noted elsewhere in this report, livestock grazing can affect predation rates by altering vegetative structure making nests more vulnerable to predators. It is also possible that the presence of livestock grazing operations in the area may have increased survival and abundance of black-billed magpies and common ravens by providing winter forage for these birds (i.e., unrecovered livestock carcasses). Thus, livestock grazing may contribute to higher nest depredation rates in several ways. Conversely, livestock grazing operations in the area may maintain lower populations of coyotes.

Introduction and continuation of livestock grazing in the Intermountain West has contributed to the introduction and spread of noxious weeds (Lacey 1987), both by depositing weed seeds in areas away from where they were ingested and by enhancing germination and growth of less palatable weeds (i.e., by lowering competiveness of native vegetation).

Broad-leaved Weeds

Non-native, broad-leaved forbs (broad-leaved weeds) is an ongoing and likely increasing threat to some refuge habitats. Livestock contribute to the introduction and spread of noxious weeds (Lacey 1987) and possibly saltcedar (pers. obs.).

Measures must be taken to eliminate (where possible) or control broad-leaved weeds. Use of livestock to control broad-leaved weeds has been shown to be effective under a variety of circumstances, and not-so-effective under other circumstances (Parman 1986, Lacey 1987, Brock 1988). In general, sheep seem to hold the most promise for controlling broad-leaved weeds (Lacey 1987, Brock 1988) and cattle apparently hold the least promise (Brock 1988). Another potential advantage in using sheep in noxious-weed control efforts is that, compared to cattle grazing, sheep grazing appears to have fewer impacts to riparian areas (Glimp and Swanson 1994).

Most references to control of weeds by livestock refer to the use of goats and sheep (Lacey 1987, Brock 1988, USBLM 1991:3-13). Lacey (1987) explained that, to be effective, the grazing animal must be adapted to using weedy plants (in our case, broad-leaved weeds). Evolutionary adaptations of different classes of livestock (e.g., cattle, sheep, goats) predisposition them to feed on particular food groups (e.g., grasses, forbs, browse)(Hanley 1982; Provenza and Balph 1987 as cited by Stuth 1991). Sheep primarily feed on forbs, and browse and grass to a lesser extent; goats primarily feed on browse, but they use all classes of forage; and cattle primarily feed on grass (Brock 1988). Cattle generally prefer eating grass in contrast to forbs (Hanley and Hanley 1982, Brock 1988, Stuth 1991). The small mouth of sheep, along with their small body size and relatively large rumen allow them to be selective feeders (Hanley 1982 for review). The rumen of cattle is large, allowing them to subsist on high cellulose forage (e.g., grass).

Dalrymple (1991) points out economic benefits of using livestock to control weeds compared to mechanical and herbicide treatments. Economic savings, however, assume that livestock (e.g., sheep or goats for controlling broad-leaved weeds) are readily available or grazing systems can merely be adjusted to control weeds in particular areas.

Brock (1988) provides two examples where cattle successfully had been used to control particular plant species: (1) cattle effectively controlled aspen suckering, and (2) cattle controlled leafy spurge through repeated trampling. The second example was based on an observation (not a study) made by Gene Foss, a rancher, as reported by Parman (1986), which Lacey (1987) pointed out has not been quantified by research. Lacey went on to discuss at length a study that documents the avoidance of leafy spurge by cattle.

Lacey (1987) provides 6 examples where cattle were used to control weeds: (1) the Parman (1986) example was discussed previously, (2) as was the study that contradicted his observation; (3) cattle effectively controlled aspen suckering (same reference used in Brock 1988); (4) cattle were not effective at decreasing the cover of clubmoss (Selaginella densa); (5) cattle have been reported to used prickly pear (Opuntia polycantha) after spines have been burned off (however, no mention was made in regard to control of prickly pear); (6) cattle were not effective in attempts to control spotted knapweed (Centaurea maculosa).

Advantages in using livestock for controlling noxious weeds, according to USBLM (1991:1-22), are: "(1) they use weeds as a food source, (2) following a brief adjustment period, they sometimes consume as much as 50 percent of their daily diet of this species, (3) average daily gains of offspring grazing certain weed-infested pastures can sometimes be significantly higher than average daily gains of offspring grazing grass pastures, and (4) sheep or goats can be used in combination with herbicides." As pointed out in USBLM (1991), these advantages mainly apply to sheep and goats. Disadvantages of using domestic animals (e.g., cattle, sheep, goats) are: "(1) they also use nontarget plants as food sources, (2) the use of domestic animals, like sheep or goats, require a herder or temporary fencing, (3) the animals may be killed by predators such as coyotes, (4) heavy grazing of some weed species, such as leafy spurge, tends to loosen the stool of the grazing animals, and (5) most weed species are less palatable than desirable vegetation and would cause overgrazing" (USBLM 1991). The dangers of the spread of weeds by livestock were discussed at length by Lacey (1987). He recommended that livestock that previously had grazed in areas infested by weeds be confined for 9-10 days before being introduced into weed-free areas. According to Lacey, cattle are major dispersers of weed seeds in some areas.

Based on the information presented above, cattle would likely have limited value for controlling broad-leaved weeds on the Stillwater and Fallon NWRs. Lacey (1987) pointed out that the effects of grazing on weed populations has not been satisfactorily evaluated in research trials, and that extensive trial and error is needed to implement a selective grazing program. He also pointed out that "the feasibility of controlling range weeds with the application of extensive livestock management practices is limited," although further research is warranted.

Management Implications: Riverine-riparian, Marsh Shoreline, and Meadow

Continued livestock grazing in these areas could hinder recovery of riparian functioning and native riparian plant communities, and would hinder the approximation of the natural composition and structure of plant communities in riparian, shoreline, and meadow areas, thus hampering the restoration of the natural diversity of wildlife in these habitats.

Given the vast acreage of periodically-flooded low-statured vegetation in the Lahontan Valley --- e.g., flooded pasture (grazed by livestock), flooded alfalfa (mowed and grazed), grazed shoreline (e.g., Harmon Reservoir, Carson Lake) — and the near absence of perennial meadow habitat in the valley, there is little need to produce additional low-statured meadow and shoreline habitat. Under natural conditions in Lahontan Valley, there would be several thousand acres of flood-plain meadow habitat, characterized in part by residual vegetation carrying over year-to-year. This contrasts with existing conditions in the Lahontan Valley where very little if any comparable habitat exists today and more than 50,000 acres of periodically-flooded low-statured vegetation. There may be small patches and short, narrow strips of vegetation of similar structure, but given their diminutive size and disconnectedness, they do not function as flood-plain habitat. Viewing the Lahontan Valley as a whole (and even the western Great Basin or the entire Intermountain West), management of meadow and similar habitats to approximate natural meadow composition and structure would appear to best contribute toward the restoration of natural biological diversity. This would likely require the complete exclusion or significant reduction in livestock grazing in riparian areas, meadows, and shorelines in the project area, except when specifically needed to control noxious weeds, in which case goats or sheep would be a preferred class of livestock.

Cattle could potentially be used to reduce or trample accumulations of dead-plant material when it is so dense that it insulates the soil and blocks light penetration (thereby inhibiting new growth) and when this would not conflict significantly with restoring and maintaining natural biological diversity (with respect to Stillwater NWR). This application, which focuses on rejuvenating waterfowl nesting habitat, would likely not have to be done more than once every 6 or more years. Furthermore, prescribed burning may be a more effective technique.

In summary, information indicates that goats and sheep can be effective as part of an integrated weed management program to control certain types of noxious weeds. It also indicates that cattle grazing would be ineffective in controlling noxious weeds.

Marsh

The use of cattle to create openings in emergent vegetation in wetland units of Stillwater Marsh has been discussed in several refuge reports. In the introduction to his *Range Survey Report*, Rouse (1955:3-4) stated that "The grazing of livestock in the marsh area is also an important factor in developing and maintaining the marsh in a condition attractive to waterfowl. The strip of open water along the shore which is developed and maintained by grazing livestock has been demonstrated to increase the value of the marsh for certain species of nesting ducks. In the absence of grazing by livestock, the marsh tends to fill in to the shore line in a solid stand of vegetation... Spring grazing which will make use of the succulent new growth of emergent vegetation, such as cattail and hardstem bulrush as it appears, helps to maintain the margin of open water along the shoreline and also helps to prevent the stand of vegetation from becoming too dense in the shallower parts of the marsh." In a 2-year study of the habitat relationships of nesting ducks, Marshall (1952:14) found that "With but several exceptions did a pair of puddle ducks locate on a pond that was completely separated from land or a dike by heavy emergent growth. Puddle duck territory required some dry land (open-shore edge) adjoining open water or low, thin emergent growth..." and that "No territories [of any species of duck] were established in heavy emergent growth such as cattail or hardstem bulrush..."

The of use of cattle to open up stands of emergent vegetation has also been reference in the published literature. In his review of literature, Kantrud (1990) described the benefits of creating openings in tall, dense emergent vegetation in marshes of the prairie pothole region by using prescribed burning and/or livestock grazing. Kantrud's (1990) paper focused on the problem of excessively dense and tall emergent wetland vegetation. Holechek et al. (1995:357) generally stated that livestock can be selectively grazed to open up dense stands of vegetation.

Whereas overly-dense tall emergent vegetation in Stillwater Marsh was reported as a problem in the early 1950s (Marshall 1952), it is not a problem at present. Part of this is due to the relative low occurrance of extensive stands of emergent vegetation at present, compared to conditions of the early 1950s. It is also a consequence of a shift in management direction that now calls for restoration of natural features of Stillwater Marsh. One consideration with respect to natural features of the marsh as it relates to livestock grazing is the existence of extensive stands of dense emergent vegetation that occurred during some periods (Gov. Land Office maps, 1868, 1882; Refuge files). Although seasonal flooding likely matted down stands of emergent vegetation, this would have occurred primarily along the main courses of water where flow rate was highest (i.e., deep-water areas). The impact of this disturbance would have lessened toward shorelines. Conversely, without controls, livestock tend to graze along shorelines and shallow-water areas first, before moving further into the marsh.

Benefits of creating openings in emergent stands primarily pertain to use of marshes by breeding pairs of waterfowl and their broods during breeding season (Kantrud 1990); discussion relative to nesting habitat was limited. Although Kantrud cited a number of sources that provide evidence that heavy grazing use — enough to create openings in marsh vegetation — can benefit some species of waterfowl, he also cited several others that reported on the adverse impacts of heavy to severe grazing of marsh vegetation and vegetation along shoreline areas. In a Stillwater WMA pond rimmed by baltic rush, cattle grazing appears to have limited or reduced the width of emergent vegetation band (observ. of the author based on cone exclosures).

Just as cattle can be used to create openings in dense emergent vegetation, they can also be used in some situations to create and sustain low-statured vegetation over expansive areas of shallow wetlands where the potential plant community would be dominated by emergents. This can be accomplished by heavy grazing or trampling or by altering vegetation composition away from emergents through the same processes. Cattle are used on Carson Lake (managed jointly by the Nevada Division of Wildlife and Truckee-Carson Irrigation District), with apparent success, to maintain low vegetation height in seasonally-flooded pastures and shallow wetlands for waterfowl and shorebird feeding habitat (L. Neel and N. Saake, Nevada Div. of Wildl., Fallon, pers. comm. 1995). Excessive livestock grazing in emergent wetlands can reduce plant vigor (Taylor 1986, Clary and Webster 1989, Platts 1989), and reduced vigor of particular species can result in changes in composition of wetland plant communities (Hargis and McCarthy 1986, Young 1986, Kovalchik 1987, Kovalchik and Elmore 1992).

Heavy grazing by cattle was used in Washington to alter shoreline vegetation composition from emergents toward annual grasses used by waterfowl broods (Harris 1954, as cited by Bundy 1993). Cattle grazing can be used to reduce dense emergent vegetation to provide germination sites for annual producers (Kantrud 1986 and Chabrek et al. 1989, as cited by Bundy 1993). In these cases, grazing of emergent vegetation is not as important as trampling of the vegetation (Kantrud 1986, as cited by Bundy). Whereas there appear to be benefits of using cattle to shift vegetation composition from emergents toward annual plants in some cases, depending on objectives, livestock grazing can also deplete annual vegetation. This can be beneficial or detrimental, depending on objectives for the area. For example, Rouse (1955:29) noted that "The greater part of the palatable herbaceous forage [eaten by cattle using Stillwater Marsh] is provided by alkali weed and Russian thistle and similar annuals which are heavy seed producers..." To the extent that non-native annual vegetation is depleted, this would tend to enhance the native diversity of plant communities. Conversely, grazing of these seed-producing annual plants during the growing season would not enhance their productivity and would likely serve only to reduce the quantity of seeds produced, thus lowering the potential benefits to waterfowl later in the year (assuming sufficient water is available to flood these areas in the fall and winter). Rouse (1955) also noted correctly that alkali weed, Russian thistle, and similar annual plants "come up abundantly in response to water and with little regard to previous grazing use." However, this does not discount the reduction in seed production in the same year that livestock grazing takes place. It also brings to question the viability of using livestock to control non-native annuals where this is desired, recognizing nontheless, that there may not be a more suitable alternative.

In addition to maintaining the low-vegetation structure preferred by some species of birds, it is also speculated that livestock grazing in marshes can increase invertebrate abundance (Kantrud 1990), which would also appear to apply to flooded pastures and meadows. However, few if any studies have examined this hypothesis. Bundy (1993) cited two studies (Whyte and Cain 1981, Whyte et al. 1981) proposing that light, controlled grazing by livestock can be used to reduce perennial stands of emergent vegetation to promote seed and invertebrate production for brood and winter habitat. However, "light" use of any given stand of emergent vegetation would likely not measurably alter plant-community structure. More likely, heavy grazing pressure would be needed in areas dominated by emergent vegetation as suggested by Marshall (1951) for this purpose.

Natural Operation of Biotic Processes

Much of the discussion under the Riverine-riparian, Marsh Shoreline, and Meadow section applies here as well. Native herbivores in emergent and submergent marshes include muskrats, coots, a great variety of waterfowl such as tundra swans, gadwall, and mallards, and many species of invertebrates grazed emergent and submergent vegetation. Aside from creating openings in dense emergent vegetation, as muskrats do, livestock likely do not approximate herbivory by these species.

Management Implications: Marshes

Cattle can be used to create openings in emergent vegetation if they don't have ready access to more favored forage or if densities are high enough to result in trampling of the vegetation. However, on Stillwater NWR, consideration must be given to the restoration of natural biological diversity, with which this application could conflict. This application of livestock would enhance nesting and brooding habitat of some species of waterfowl and other waterbirds. However, if not strictly controlled, using livestock to create openings in dense emergent vegetation could result in heavy to severe grazing on nearby shorelines and reduction of nesting habitat for species dependent on such dense vegetation.

Uplands

By reducing the amount and height of residual herbaceous cover in uplands, cattle grazing can effect wildlife species that depend on this component of the environment. Rouse (1955) believed that early spring use by livestock in upland areas was responsible for the disappearance of Indian ricegrass, a keystone species in plant communities in which it occurs. He recommended that spring turn-out be delayed until May 15 to reduce adverse impacts to upland plants.

In general, livestock grazing can advance the rate of succession from a grass-dominated to a shrub-dominated state where perennial grasses and forbs are grazed frequently and intensively during the growing season (Ellison 1960, Tisdale and Hironaka 1981, Blaisdell et al. 1982, Monsen and McArthur 1985, Winward 1985). No published information was found on the effects of livestock grazing on shrub cover in salt desert shrub communities. However, such information does exist for sagebrush communities, which occur at slightly higher elevations than the salt desert shrub communities of the Stillwater area. Cover of herbaceous plants has been found to inversely relate to cover of sagebrush beyond a threshold level (e.g., >15% cover of Wyoming big sagebrush) that differs with site potential (Sneva et al. 1984, Winward 1991, Laycock 1991). In the intermountain west, increase in cover of sagebrush and other shrubs is associated primarily with frequent, intensive use of herbaceous plants during the growing season coupled with fire exclusion (Ellison 1960, Laycock 1967, Blaisdell et al. 1982, Heady 1983, Kauffman 1990). To the extent that livestock grazing has reduced the cover and abundance of perennial bunch grasses and other herbaceous vegetation in salt desert shrub communities, shrub cover may have increased in response.

Livestock grazing appears to have had a major effect on condition of some upland plant communities in the Stillwater area (Rouse 1955, Wiseman 1962, Charlet 1997). Ecological communities in the northern Great Basin were affected by herbivorous hoofed mammals only to a limited degree prior to introduction of domestic livestock (Young et al. 1976, Mack and Thompson 1982, Miller et al. 1994), especially in salt desert shrub communities in which production of herbaceous vegetation was comparatively low. Collectively, bunchgrasses are less resistant to frequent grazing, especially during growing season, compared to sod-forming grasses characteristic of the Great Plains (Blaisdell et al. 1982, Mack and Thompson 1982).

Much has been written about the benefits of livestock grazing in upland areas of the Western United States. However, although the removal of standing dead plant material on a periodic basis is considered beneficial to plant health by some authors (Savory 1988, Anderson 1993), standing dead plant material has been shown to be beneficial to plant health by others (Sauer 1978, Sneva 1980, Briske 1991). Others have found neutral effects of

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removing dead plant material during the dormant season (Britton et al. 1990). Furthermore, no studies were located that identified any vegetation benefits associated with livestock grazing in upland areas receiving less than 6 inches of precipitation per year on average. Holecheck et al. (1995:129) pointed out that positive effects of controlled livestock grazing would most likely occur in areas receiving at least 16 inches of precipitation per year on average. They surmised that excessive accumulations of dead plant material generally does not occur due to aridity. With respect to benefits to wildlife, they asserted that benefits of controlled grazing generally would not occur in areas receiving less than 20 inches of precipitation per year (Holechek et al. 1995:357).

The discussion in the preceding paragraph does not fully address the ecological perspective of restoring natural biological diversity. From this standpoint, benefits to individual plants are of secondary importance to the natural composition and structure of vegetation. Even if livestock grazing were to increase plant vigor, this could diminish natural vegetative diversity in the area. Given the limited grazing pressure on native bunchgrasses in the Carson Desert and slow decomposition rates, accumulations of dead plant material was only one component of the habitat in which they evolved.

Two potential benefits of cattle grazing have been identified specific to the Stillwater area: (1) pushing existing Indian ricegrass seeds below the soil surface through hoof action (R. Mills, Fallon, Nevada, pers. comm. 1995), and (2) removing cheatgrass residues after the growing season to reduce fire potential (W. Longland, Agric. Res. Serv., Reno, Nevada, pers. comm., 1997). Specifically regarding the actual placement of seeds and their germination, the first hypothesis seems plausible given the germination requirements of Indian ricegrass. In describing planting methods for revegetating disturbed lands, Wasser (1982) recommended drilling seeds 1-1/2 to 3 inches deep in medium course-textured soils, noting that seeds emerge well from 4 inches in sand, although Young et al. (1994) found that seedlings emerged best from depths of 6 inches, as compared to shallower depths. These deep planting depths stem from the symbiotic relationship that has formed between Indian ricegrass and kangaroo rats, which bury Indian ricegrass seeds in caches (Longland 1992). Although it seems likely that cattle can trample Indian ricegrass seeds deeper into soils, thus enhancing germination, the benefits of this approach on Stillwater NWR or Fallon NWR would seem to be outweighed by the adverse impacts of cattle grazing. Areas supporting Indian ricegrass also have populations of kangaroo rats, and wind-blown sand also acts to bury Indian ricegrass seeds. As Indian ricegrass populations are permitted to increase, kangaroo rat populations would likely expand as well, thus increasing the potential for further expansion of Indian ricegrass stands. One method to supplement Indian ricegrass stands would be to provide seed to kangaroo rats and other rodents in feeding devices or to broadcast seed in areas occupied by these rodents (Barrow and Havstad 1992).

To the extent that cattle would forage on standing dead cheatgrass during the late summer after the growing season and before the highest potential for fire, they could be effective in reducing the potential for ignited fires to spread. However, to be effective, this would have to be done every year over large areas. Furthermore, because other green forage (e.g., greasewood and other shrubs) and other palatable vegetation (e.g., dormant Indian ricegrass plants) would be available during the late summer, cattle would not limit their foraging to standing, dead cheatgrass.

Natural Operation of Biotic Processes

Large ungulates that would use the Lahontan Valley under natural conditions include mule deer (existing today), and occasional pronghorn (rare occurrences today), bighorn sheep (non-existent today), and possibly an occasional elk or bison (non-existent today). These species may have grazed or browsed in uplands, but this likely would not have been extensive given the low production of these lands. However, black-tailed jackrabbits, white-tail antelope ground squirrel, Merriam kangaroo rats, and a large number of invertebrates grazed and browsed in upland habitats.

Control of location, timing, and intensity of livestock use determines which foods are selectively used by livestock and whether livestock-use significantly influences plant succession (Ellison 1960, Blaisdell et al. 1982, Blaisdell and Holmgren 1984, Platts and Nelson 1985). Because large ungulates are not a natural component of salt desert shrub or dune ecosystems, the potential is high for cattle to interfere with natural successional patterns.

Control of Cheatgrass and Enhancement of Native Perennial Grasses and Forbs

Livestock grazing has been examined as a means to control cheatgrass at least as far back as the 1940's (Vallentine and Stevens 1992). Livestock grazing also is generally considered a factor in promoting the establishment and prominence of cheatgrass (Vallentine and Stevens 1992). The concept of using cattle to control cheatgrass and enhance native perennial grasses was described by Krueger and Buckhouse (1993) as follows. Cattle grazing conducted early in the spring, when cheatgrass is rapidly growing and native bunchgrasses have not yet begun to grow would adversely impact cheatgrass while having minimal impacts on native bunchgrasses. If cattle are removed while adequate soil moisture remains, bunchgrasses would complete their development. Under this treatment, cheatgrass would decline in abundance and native perennial bunchgrasses would increase in cover. This conceptual framework is consistent with that provided by Vallentine and Stevens (1992). They cite several studies that demonstrate that clipping and grazing by livestock can hinder the growth of, or kill, cheatgrass.

There does not appear to be any studies, however, that demonstrate that cheatgrass growth can be hindered without impacting native perennial bunchgrasses. Vallentine and Stevens (1992) reason that sufficient information probably does not exist to carry out the precise control over cattle grazing that would be required to effectively control cheatgrass within a narrow window of opportunity that may exist. J. Young (Agric. Res. Serv., Reno, Nevada, pers. comm., 1993) noted that many times native bunchgrasses are emerging prior to emergence of cheatgrass. Tisdale and Hironaka (1981) found that native perennial grasses were more adversely impacted than cheatgrass following simultaneous clipping.

Valentine and Stevens (1992) concluded that livestock grazing is not an effective method of controlling cheatgrass. Sanders (1992), in assessing its practicality, found that the preponderant evidence indicates little chance of conversion from annual to perennial grassland communities through grazing management in areas receiving less than 12 inches of precipitation per year. The Stillwater area receives an average of less than 5 inches of precipitation per year (Dollarhide 1975).

Management Implications: Uplands

Livestock grazing does not appear to be an appropriate method for restoring and sustaining healthy uplands and natural biological diversity in uplands. Few applications of livestock grazing were identified that would apply to the upland areas in the project area. I am unaware of any information suggesting that natural herbivory rates would not occur, or are not occurring, on the refuges given sufficient recovery of habitats and subsequent response by native herbivores. In cases where the purpose of a particular application was consistent with refuge goals and purposes (e.g., controlling cheatgrass), available information indicates that livestock would be ineffective for the purpose at hand.

Farmland

Cattle grazing can increase the abundance of edible green shoots in goose feeding areas (Greenwalt 1978, as cited by Strassman 1987). USFWS (1992d) cited another example in which moderate livestock grazing was used to create feeding habitat for wintering waterfowl.

Cattle are used in the Lahontan Valley to maintain low cover of weeds (along with the planted crop) until the growing season of the desired crop (Bill Henry, U.S. Fish and Wildl. Serv., pers. comm., 1998). In cases where farmers produce crops on refuge lands (agricultural fields west of Hunter Road and south of the Canvasback Gun Club), cattle would appear to be an appropriate way to impede growth of plants until the growing season of the planted crop.

In farmland areas, adverse impacts to native plant communities obviously is not a major concern. Thus, options for using cattle for the purposes described above are not limited to any large extent by environmental concerns.

SCIENTIFIC RESEARCH, ENVIRONMENTAL EDUCATION, AND WILDLIFE-ORIENTED RECREATION

Public Law 101-618 requires that opportunities for scientific research, environmental education, and wildlife-oriented recreation be provided on Stillwater NWR. The Nevada Chapter of The Wildlife Society identified a need in Nevada to set aside large areas as ungrazed, control areas to study the impacts of livestock grazing (Nevada Chapt. of The Wildl. Soc. 1995).

With respect to environmental education and wildlife-oriented recreation, the NWRS Administration Act, as amended, directs the Service to facilitate wildlife-dependent recreation (including environmental education and interpretation) to the extent that it is compatible with refuge purposes and the Refuge System mission. One of the principles outlined in Executive Order 12996 is that opportunities for wildlife-dependent recreation can only be provided to the extent that high quality habitat exists to provide for the needs of wildlife. Thus, livestock grazing can affect the Service's ability to meet public-use management mandates by negatively and positively affecting wildlife and wildlife habitat. These effects comprise the bulk of this report.

Livestock grazing can affect recreation experiences by influencing where people choose to view wildlife. According to public comment, the presence of cattle can have a negative impact on visitors' experiences. Riparian areas and marshes are popular places for birdwatching and viewing other types of wildlife viewing, and cattle in these areas may disturb these wildlife enthusiasts. Fences on the Refuge may hinder recreation experiences for those seeking a natural appearing environment.

CULTURAL RESOURCES

Livestock grazing can increase the chance of surface artifacts and exposed burials being trampled. Because heavy and severe livestock grazing can expose soil surface, it can also expose artifacts which would otherwise by covered with vegetation, thus increasing the possibility of theft.

CONCLUSIONS

After evaluating the effects of the existing livestock grazing program of season-long use and potential applications of livestock grazing as a management tool, several applications of livestock grazing that could potentially be used to help accomplish the goals of Stillwater NWR and Fallon NWR were idenified in this report. They are:

- the use of sheep and goats as part of an integrated pest management plan to control noxious weeds;
- the use of cattle to control weeds in farm fields and along associated irrigation ditches;
- the use of cattle to enhance vegetation in farm fields for Canada geese and other waterfowl;
- the use of cattle to create openings in dense stands of emergent vegetation, recognizing that extensive stands of dense emergent vegetation are part of the natural marsh ecosystem; and
- possibly the periodic (once every 6-7 years or more) use of cattle to reduce accumulations of dead plant material in meadows, irrigated pastures, and along shorelines to rejuvenate vegetation used for nesting cover, recognizing that accumulations of dead plant material over extensive areas is a natural part of the ecosystem and a missing element of riparian and other wetland communities throughout the west.

These potential uses are generally consistent with the recommendations received from the July 1997 Habitat Management Workshop. They are further addressed in a compatibility determination addressing livestock grazing on Stillwater and Fallon NWRs.

One factor that must be considered in any livestock grazing program on a national wildlife refuges was characterized by Braun et al. (1978:311): "...when grazing is allowed [on a national wildlife refuge], the USFWS

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frequently loses control of local situations due to intense political pressure at all levels of administration." To the extent this is true, it can have significant effects on programs that are initially well designed with the needs of wildlife at the forefront. This ultimately means that livestock grazing should only be used on refuges if it is absolutely necessary to achieve refuge purposes and there are no other feasible management tools at the manager's disposal. Although the five applications listed above were identified as ones that could be used toward achieving draft refuge goals, none are absolutely necessary. Aside from the first listed application, none apply to the main thrust of management of Stillwater NWR, that of restoring or approximating natural habitat conditions and the health of the ecosystem.

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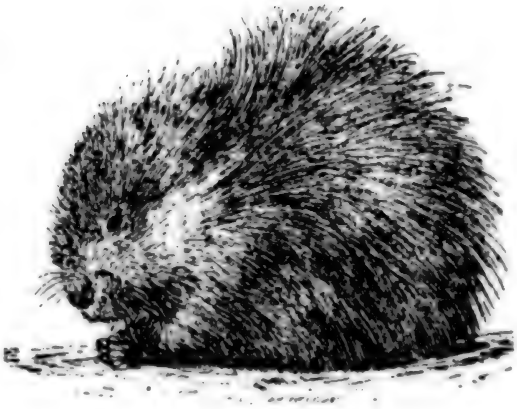
APPENDIX N:
Cause-and-Effect Analysis of Factors Affecting the Natural Biological Diversity and Natural Habitat Conditions on Stillwater NWR Complex



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CAUSE-AND-EFFECT ANALYSIS
With Respect to Natural Biological Diversity and Natural Habitat Conditions, with Emphasis on Marsh and River Habitats

on Stillwater National Wildlife Refuge,
Stillwater Wildlife Management Area, and
Fallon National Wildlife Refuge
(March 2000)

INTRODUCTION

Developing management objectives and strategies for national wildlife refuges in a biologically, scientifically, and legally sound fashion is essential if the National Wildlife Refuge System is to "stand as a monument to the science and practice of wildlife management," as was one of the intents of Congress in passing the National Wildlife Refuge System Improvement Act of 1997 (House Report 105-106). This will require a directed approach to wildlife management founded in ecological and wildlife management principles and scientific information, as opposed to management that is pulled here and there by short-term, perceived emergencies and changing interests. This in turn will require that the objectives and strategies contained in comprehensive conservation plans be developed in a way that focuses management attention on the underlying factors governing the achievement of wildlife and habitat goals and that objectives and strategies are founded in sound principles and available science. Furthermore, the Refuge System Improvement Act requires, as part of the comprehensive conservation planning process, the Service to identify the significant problems that may adversely affect populations and habitats of fish, wildlife, and plants with the planning unit and the actions necessary to correct or mitigate such problems.

Carrying out a cause-and-effect analysis using sound principles and available scientific information can contribute toward meeting these needs. Cause-and-effect analyses are used to isolate underlying reasons why desired conditions are not being achieved (Coughlan and Armour 1992), and similar analyses can be performed to identify underlying factors maintaining a particular set of conditions that are already existing. This report begins with an overview of the comprehensive conservation planning process at the Stillwater National Wildlife Refuge (NWR) Complex, which includes Stillwater NWR, Stillwater Wildlife Management Area (WMA), and Fallon NWR. This is followed by a description of the methods used in analyzing problems occurring on Stillwater NWR and the results of the cause-and-effect analysis. The report ends with a discussion of several management applications of the result of the cause-and-effect analysis.

MANAGEMENT CONTEXT

A comprehensive conservation plan is being developed for the Stillwater NWR Complex. Under two alternative boundary revisions for Stillwater NWR, all or major parts of Stillwater WMA and Fallon NWR would be added to Stillwater NWR. Lands not included within Stillwater NWR under the alternatives would be relinquished. Because this report only addresses problems existing within the Stillwater NWR, Stillwater WMA, and Fallon NWR (lands within the potential new boundary of Stillwater NWR), references to Stillwater NWR Complex hereafter do not include Anaho Island NWR.

Based on refuge purposes outlined in the Truckee-Carson-Pyramid Lake Water Rights Settlement Act of 1990 (Title II of Public Law 101-618), and ensuring consistency with the NWRS mission, pertinent legislation and executive orders, Service policy, and international treaties, the following goals have been proposed for Stillwater NWR: (A) conserve and manage fish, wildlife, and their habitat to restore and maintain natural biological diversity; (B) fulfill obligations of international treaties and other international agreements with respect to fish and wildlife; and (C) provide opportunities for scientific research and wildlife-dependent recreational uses that are compatible with refuge purposes. A common

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theme of the international treaties that apply to Stillwater NWR is the restoration of natural ecosystems and natural habitats. Consequently, the focus of wildlife and habitat management under these goals is on the approximation of natural biological diversity, recognizing that adjustments in management may be needed to address the needs of certain wetland-dependent bird species. Natural biological diversity comprises the diversity within and among biotic communities that evolved in the Lahontan Valley under geological, evolutionary, and other ecological processes apart from human influence, which is consistent with U.S. Fish and Wildlife Service (Service) definitions of "natural" and "biodiversity."

Refuge managers are bombarded with large numbers of problems and issues, especially on more complex refuges like Stillwater NWR. Faced with so many issues and challenges, it is imparitive that managers prioritize the issues to be addressed (e.g., the significant problems), due to limited budgets and staff, to ensure that sufficient resources are applied toward resolving the problems that are ultimately limiting the accomplishment of refuge purposes. One tool that can assist managers is a diagram that illustrates the many cause-and-effect relationships and the ultimate, root causes of the major problems limiting achievement of refuge purposes. The purpose of this report is to identify the problems facing Stillwater NWR/WMA and Fallon NWR and to identify the underlying reasons why these problems exist.

SUMMARY OF THE PROBLEM

As is discussed later in this report, there are long lists of problems on the Stillwater NWR Complex, as with most every refuge in the Refuge System. But what are the ones of primary concern on the refuge complex?

Traditionally, the main interest has been waterfowl and, more recently, shorebirds and other waterbirds have received increased interest. Regardless of the management direction that is adopted at the end of the current planning process, these groups of birds will continue to be a focal point of management. Prior to the onset of the water-rights acquisition program for Lahontan Valley wetlands, significant reductions in water supply, as compared to natural conditions and even as compared to the early and mid-1900s, greatly impacted the number of waterfowl and other waterbirds using the Lahontan Valley for nesting, migration, and wintering. This led to a water-rights acquisition program for Lahontan Valley wetlands, including Stillwater NWR. However, even with the implementation of the wetlands water-rights acquisition program outlined in the Final Environmental Impact Statement for Water Rights Acquisitions for Lahontan Valley Wetlands (USFWS 1996), water supply will continue to be a concern due to: continued litigation of the program and individual water-rights transfers, uncertainty of obtaining anticipated supplies from some sources (e.g., Naval Air Station-Fallon, groundwater, leased water), which comprise a considerable amount of the targeted volume. Assuming that the water rights acquisition program is completed, the volume of water would only be marginally sufficient to restore Stillwater Marsh given the purposes for which Stillwater NWR is to be managed.

In addition to the reduced water flows into Stillwater Marsh and other Lahontan Valley wetlands due to the Newlands Project and agriculture and other water users, contamination of wetland inflows has also become a concern. With agricultural drainwater being the only wetland inflow outside of spill years, concentrations of total dissolved solids and trace elements rose significantly over natural conditions. In the 1980s, concentrations of arsenic, boron, selenium, sodium, mercury, and unionized ammonia were found to be above Federal and State criteria for the protection of aquatic life and propagation of wildlife. These trace elements and other toxins pose a threat to the area's waterbirds and other wetland wildlife. Although the acquisition of additional water rights will continue to reduce these impacts, through reductions in drainwater inflow (as less water is applied to agricultural fields near the refuge) and dilution of drainwater that continues to flow into the refuge, contaminants will continue to be a concern. Any use of groundwater may, depending on where pumping occurs, offset gains made through acquiring water rights. Furthermore, increasing the rate of inflow of spill-waters from Lahontan Reservoir during large flood events brings with it the potential to increase the rate of mercury importation.

Notwithstanding, however, wetland inflow volumes and most contaminant concerns are being actively addressed through the ongoing, water-rights acquisition program. As yet, there are two significant threats to native plant and animal communities on the Stillwater NWR Complex that have not been addressed to any large degree: the introduction and spread of non-native species and mercury contamination. Likely the greatest threats at present are the singular and combined impacts of non-native species, especially saltcedar, Russian olive, perennial white-top, cheatgrass, cattle, European carp, various species of gamefish, mosquito fish, bullfrogs, and European starlings. These and other non-native species can have marked impacts on native wildlife communities and populations. Saltcedar has completely altered some habitats to the exclusion of many species of native wildlife; non-native fish now dominate fish communities; livestock grazing is one of the leading factors that has dramatically altered several native vegetation communities and associated wildlife; cheatgrass has the potential to completely alter upland vegetation communities to the exclusion of native species; bullfrogs are likely a significant contributing factor to the near eradication of leapord frogs in the area; and European starlings are aggressive competitors that have likely significantly altered the community of cavity-nesting species along the lower Carson River.

In the lower Carson River, the major factors that continue to impair riverine and riparian habitat are a significantly reduced water supply, spread of non-native vegetation (especially saltcedar, Russian olive, and white-top), and season-long livestock grazing. All of these factors are interrelated, the results of which is a markedly altered river and riparian community. Yellow-billed cuckoos, yellow-breasted chats, western harvest mice, and freshwater invertebrates no long inhabit the area and the diversity of neotropical migrants is far below the potential of the area. Another potential problem of the Carson River system no longer functioning in its natural condition is that the river no longer carries sand deposits to its delta, which could potentially impact the dune system along the southern shore of the Carson Sink.

Although human disturbance likely does not impact native wildlife communities to the same degree as altered hydrology and introduction of non-native species, it has the potential to measurably affect these communities under the existing public-use management program. The Service is required to ensure that public use activities occurring on Stillwater NWR do not measurably impair the Service's ability to restore the area's natural biological diversity.

CAUSE-AND-EFFECT ANALYSIS

A cause-and-effect analysis can provide important links between goals and objectives or between objectives and strategies by identifying the underlying reasons why goals or goals are not being reached. A cause-and-effect analysis is much more than problem identification (Coughlan and Armour 1992). By conducting a cause-and-effect analysis, long-range objectives and/or subsequent strategies can be formulated in such a way that they focus limited resources on the root of the problem, thereby avoiding a band-aid approach to management.

Coughlan and Armour (1992) discussed the problem analysis process in detail, presenting several different methods of analyzing problems. To examine cause-and-effect relationships between wildlife and plants, their habitat, and the processes that shape habitat at Stillwater NWR, the Watson's circles approach was used and it was supplemented by a cause-and-effect tree. The Watson's circles technique is fairly "user friendly" and can be used in conjunction with one or more other methods such as cause-and-effect trees. Whereas Coughlan and Armour (1992) specified that Watson's circles were useful for evaluating the causes of problems when 10 or less problems are involved, it can be used with many more problems than this. However, the more problems it is used to analyze, the messier and more confusing the process becomes. Cause-and-effect trees are useful for exploring problems further.

Methods

An all-day planning meeting was conducted on 12 June 1997 at the Stillwater NWR Complex office in Fallon, Nevada. The meeting began with an explanation of the basis and rationale for conducting a cause-and-effect analysis, and an explanation of the analysis itself. Also presented was a summary of estimated natural hydrologic and vegetative conditions. Participants of the meeting were:

Stillwater NWR Complex Office:
Bob Flores, Deputy Refuge Manager
Bill Henry, Wildlife Biologist
Rob Bundy, Wildlife Biologist
Bob Henderson, Eng. Equipment Operator/Law Enforcement Officer
Janet Schmidt, Outdoor Recreation Planner
Don DeLong, Wildlife Biologist/Planning-team Leader
Ecological Services, Nevada State Office in Reno:
Mary Jo Elpers, Supervisor, Federal Projects, Permits, and Licenses
Pete Tuttle, Assistant Contaminant Specialist

Problem Identification

The first step was to list all pertinent problems and their symptoms. To make the process easier to follow and to simplify future steps, major-category headings were identified at the top of several pieces of flip-chart paper taped to the walls. Participants were then asked to start identifying problems and their symptoms that they perceived within the Stillwater NWR Complex. These were listed on a flip chart under the appropriate headings. "Problems" included limitations to achieving natural ecological conditions, recognizing that some of these limitations may not be considered a problems given other goals and objectives (i.e., those not targeting natural conditions).

Cause-and-effect Analysis

The Watson's circles approach was originally published in a business magazine (Watson 1976). This four-step technique has since been used to analyze causes and symptoms of natural resource problems in order to isolate one or more root causes of these problems (Coughlan and Armour 1992). After identifying all pertinent problems and their symptoms, the list was shortened by combining similar problems because the Watson's circles technique becomes cumbersome with large numbers of problems. These representative problems were written on a paper-covered wall. Each problem was circled, leaving a relatively large amount of space around each circled problem to allow room for arrows to be drawn.

The third step was to identify the cause-and-effect relationship between problems. For each circled item, an arrow was drawn from each problem to all other problems that the particular problem causes or helps to cause (i.e., its symptoms). Participants then considered the following questions for each circled problem: "to what other problems does this problem lead or contribute?" (draw arrow toward other circles) and "what are the causes of this problem?" (arrow is drawn from other circles toward this one). The fourth step was to sort through the network of arrows to isolate the root cause(s) of the problems (Fig. 1c). Root causes of problems are those that have arrows pointing away from them, but none pointing toward them. However, whereas the ultimate goal of the process is to identify root causes of problems, this may not always be a straightforward procedure. The factor(s) that originally caused a particular set of habitat problems (i.e., ultimate causes) may not necessarily be the same that maintain the habitat in degraded condition (proximate causes). This is discussed further in the results section.

Following the identification of root causes of problems by the group using the Watson's circles technique, the hydrologic information was reformatted by the author of this report into a cause-and-effect tree, facilitating a better understanding of the relationships and making cause-and-effect relationships easier to visualize. For instance, by moving progressively backward (backward analysis)(Erickson 1981, Coughlan and Armour 1992) from a given ecological condition, factors producing this condition can be traced back to the ultimate factors that cause the condition.

Results

Problem Identification

Five major categories of potential problems were identified and each was written on the top of flip-chart paper. Using these categories as a guide, a total of 99 potential problems were identified by the group (Table 1), and this list was shortened to 29 representative problems (Table 2). These problems were addressed by the group in the Watson's circles analysis.

Following the Watson's circles analysis, the identified problems were assessed by the author of this report to ascertain the major differences between natural and existing ecological conditions in major habitat groups: marsh (e.g., Stillwater Marsh, Battleground Marsh), river/river-riparian (e.g., Carson River, Stillwater Slough), and uplands (e.g., salt desert shrub, sand dunes); and off-refuge environments (Table 3). These problems represent the major symptoms of processes not operating at natural levels, among other alterations to the ecosystem.

Cause-and-effect analysis

The Watson's circles exercise carried out by Service personnel (Figure 1) and further analysis using cause-and-effect trees (Figure 2) revealed that the following are the major underlying factors affecting biological diversity within the Stillwater NWR Complex that can be addressed on these lands:

- altered topography and restricted flow;
- presence and spread of nonnative species, including domestic livestock; and
- unnaturally-high concentrations of contaminants in soils.

The major underlying factors affecting the Service's ability to approximate natural biological diversity and natural habitat conditions within the Stillwater NWR Complex, regardless of where the problems must be addressed are as follows. The superscript '$^{\text{OFF}}$' designates off-refuge factors and '$^{\text{ON}}$' designates on-refuge factors, which many times are a result of off-refuge factors (the associated '$^{\text{OFF}}$' factor). Two asterisks (**) indicate the three underlying factors that can be addressed through habitat management on the refuge. One asterisk (*) indicates factors that can be addressed through public use management and wildlife population management on the refuge.

1^{OFF} insufficient amount and altered timing of inflow;
** 1^{ON} altered topography and restricted flow;

2^{OFF} influx of nonnative species (can partially be addressed through management);
** 2^{ON} presence and spread of nonnative species, including domestic livestock;

3^{OFF} inflow of unnaturally-high concentrations of contaminants;
** 3^{ON} unnaturally-high concentrations of contaminants in soils;

4^{OFF} land-use practices throughout the Western Hemisphere (i.e., effects on migratory bird populations);
4^{ON} altered populations on Stillwater NWR

5^{OFF} public interest in using refuge (local-global) and altered populations of predators;
* 5^{ON} altered disturbance, mortality, and possibly predation rates

Table 1. List of factors on Stillwater National Wildlife Refuge, Stillwater Wildlife Management Area, and Fallon National Wildlife Refuge, Nevada, that are different now than they would be under natural conditions (i.e., potential problems)

CONTAMINANTS

INTRODUCED
Mercury
Pesticides
--herbicides
--insecticides
--fungicides
Sewage
Urban Runoff
--petroleum based
--antifreeze
--fertilizers
--household chemicals
Accidental Spills
Lead Shot
Ordnance

NATURAL
Changed Trace Elements in soil
-load increase
Aluminum
Dissolved Solids

VEGETATION

Encroachment of Exotics
Increase in Groundwater - effects on vegetation
Livestock Grazing
Reduction of
--communities of submergents due to lack of fresh water
--riparian vegetation
--Great Basin wild rye
--Indian rice grass
--vegetation height in meadows
Beaver
Change in
--proportion of submergents emergents upland communities
--proportion of cattail bulrush (favoring cattail)
--insect plant relationships
--woody material
--recruitment opportunity
--size shape of wetlands wetland communities
--nesting cover
Introduction of Agricultural Crops
Habitat Fragmentation

HYDROLOGY

Timing (seasonal flow pattern)
Flow Volume
Water Quality
salinity
nutrients
crop fertilization
dissolved oxygen
trace elements
More Shallow Water
Restricted Flow Pattern
diking
smaller wetland unit size
high water flows restricted by dikes
change in water entry points
--groundwater and discharge
reduced flushing flows
proportion of water depth
loss of floodplain riparian
increase in seep ponds
aquatic animal corridor restriction
channelization
water retention
loss of flow-through dynamics
delivery through canals (vice natural)
delivery efficiency differs from natural
annual variance
reduction floodplain
loss of river-associated wetlands
introduction of artesians
restricted river channel dynamics
maintenance of hydric soils
sediment deposition
Change in Flow Due to Flooding

WILDLIFE

Reduction in
riparian-dependent wildlife
fisheries
fishing birds
burrowing animals
shorebird populations
waterfowl population
populations of small mammals
Introduction of exotic fish
competition
Seep Pond Invertebrates
Loss of Clams Mussels
Shift in Aquatic Invert Species
Competition of Exotics (starlings, etc)
Predation
ravens
Introduced parasites Diseases
Botulism
Feral Predators (cats, dogs)

DISTURBANCE

Noise Pollution
Nest Flooding
Fire
Change in Deflation Procedures
Human
roads
boats
vehicles
hunting
scientific research
public use
Livestock

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Table 2. Consolidated list of potential problems from Table 1, used in the Watson's circles analysis.

CONTAMINANTS	VEGETATION	HYDROLOGY	WILDLIFE	DISTURBANCE
Introduced	Change in upland communities	Timing of flows	Reduction in riparian-dependent wildlife	Human disturbance
Natural	Change in wetland communities	Flow volume	Introduction of exotic animals	Nest Flooding
	Change in riparian communities	Water quality	Fisheries and herp reduction	Livestock
	Encroachment of exotics	More shallow water	Reduction of burrowing animals	
	Beaver	Restricted flow	Parasites/diseases	
		Ground water	Change in waterfowl/water birds	
			Change in shorebirds	
			Change in aquatic inverts	
			Predator increase	
			Predator decrease	

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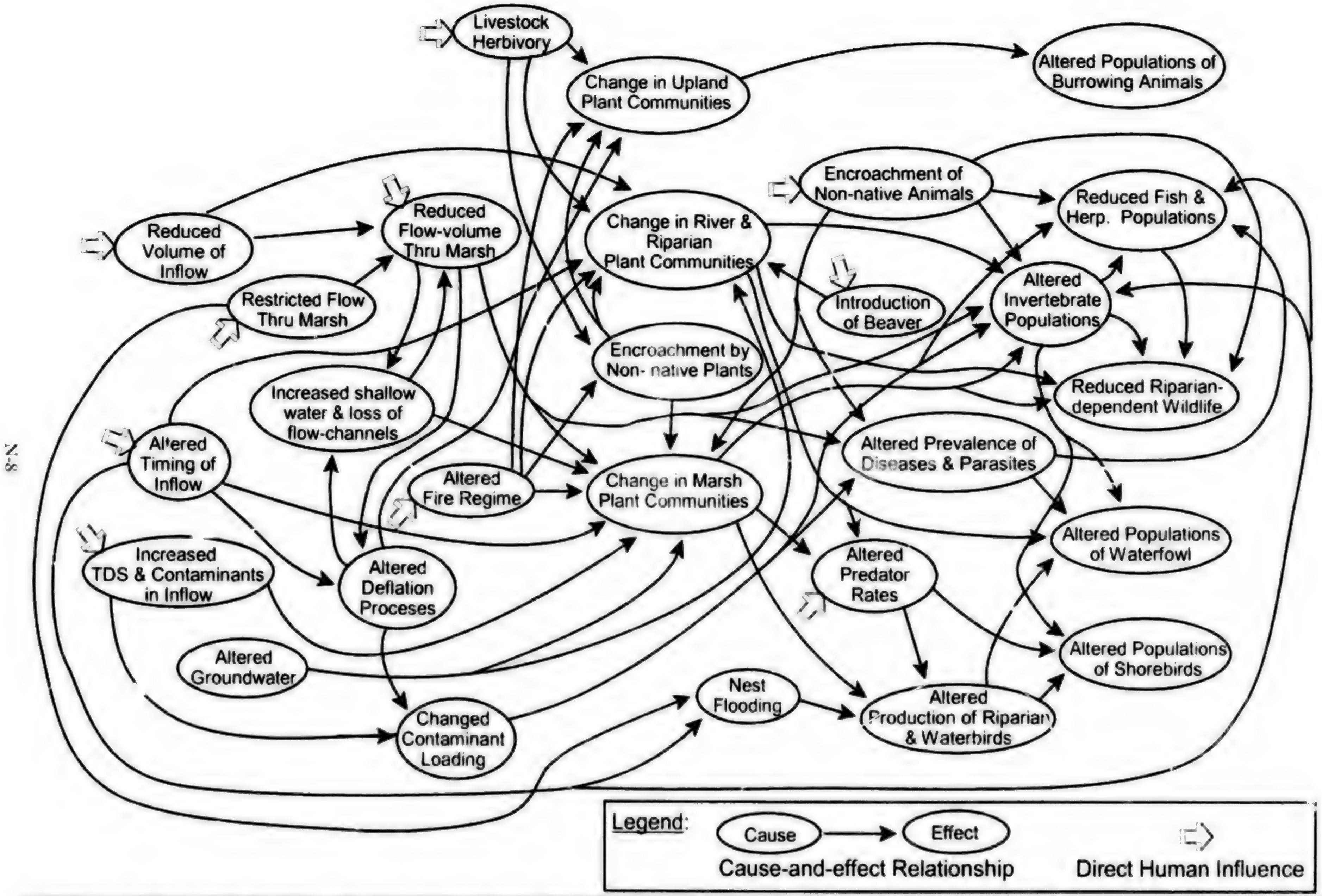
Livestock Herbivory
Change in Upland Plant Communities
Altered Populations of Burrowing Animals
Reduced Volume of Inflow
Reduced Flow-volume Thru Marsh
Change in River & Riparian Plant Communities
Encroachment of Non-native Animals
Reduced Fish & Herp. Populations
Restricted Flow Thru Marsh
Introduction of Beaver
Altered Invertebrate Populations
Encroachment by Non- native Plants
Increased shallow water & loss of flow-channels
Reduced Riparian-dependent Wildlife
Altered Timing of Inflow
Altered Fire Regime
Change in Marsh Plant Communities
Altered Prevalence of Diseases & Parasites
Altered Populations of Waterfowl
Increased TDS & Contaminants in Inflow
Altered Deflation Proceses
Altered Predator Rates
Altered Groundwater
Altered Populations of Shorebirds
Nest Flooding
Altered Production of Riparian & Waterbirds
Changed Contaminant Loading
Legend:
Cause
Effect
Cause-and-effect Relationship
Direct Human Influence

Figure 1. Watson's circles excercise carried out by U.S. Fish and Wildlife Service personnel (as modified by the author) fordetermining the underlying factors limiting the approximation of natural biologiial diversiity within the proposed boundary of Stilillwater National Wiildlife Refuge, Nevada.

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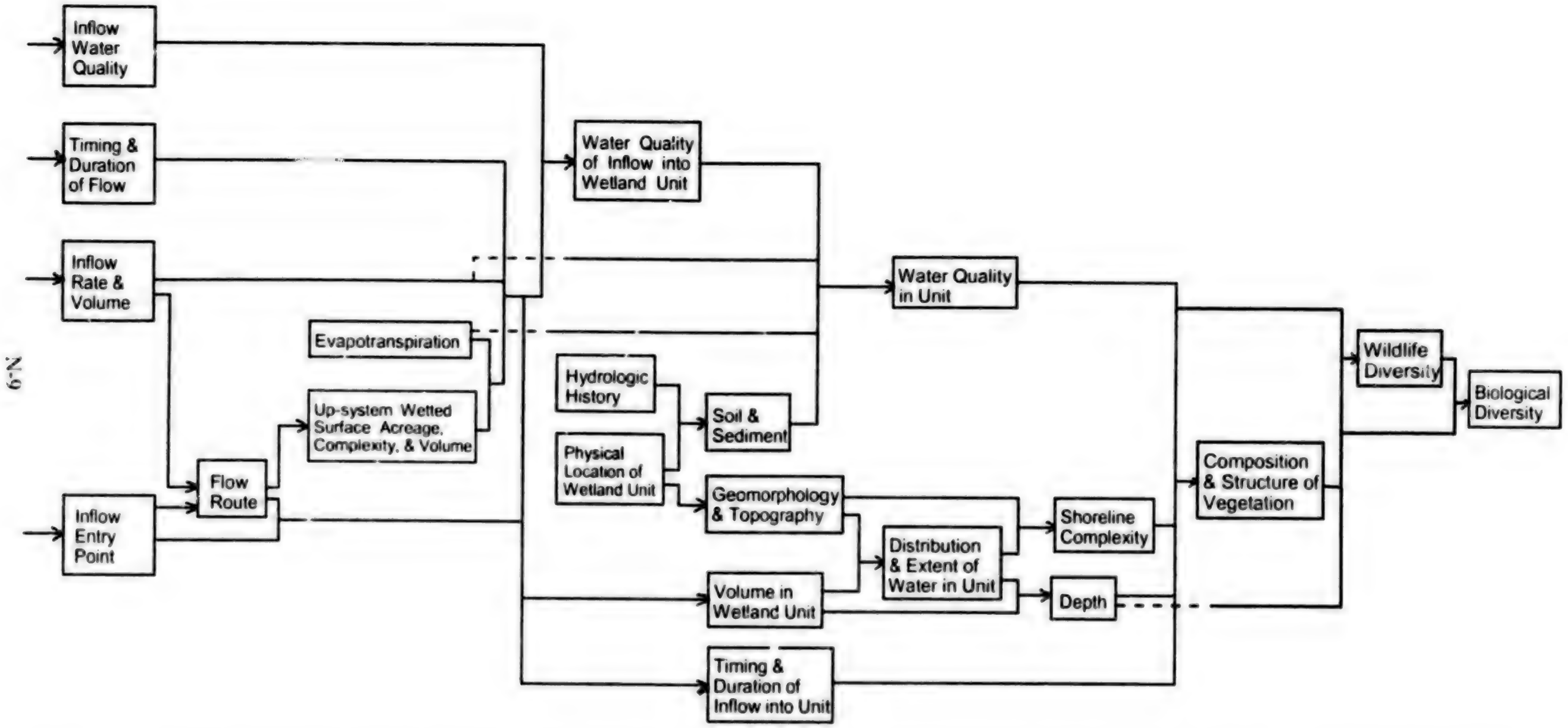
Inflow Water Quality
Timing & Duration of Flow
Inflow Rate & Volume
Evapotranspiration
Up-system Wetted Surface Acreage, Complexity, & Volume
Flow Route
Inflow Entry Point
Water Quality of Inflow into Wetland Unit
Hydrologic History
Physical Location of Wetland Unit
Soil & Sediment
Geomorphology & Topography
Volume in Wetland Unit
Timing & Duration of Inflow into Unit
Water Quality in Unit
Distribution & Extent of Water in Unit
Shoreline Complexity
Depth
Composition & Structure of Vegetation
Wildlife Diversity
Biological Diversity

Figure 2. A simplified cause-and-effect tree ilustrating the on-refuge hydrologic factors affecting biological diversity in Stillwater Marsh. For each factor identified in the cause-and-effect tree, the factor depicted to the right is caused or influenced by those to the left. The four factors listed at the far left of the figure are significantly, and in some cases totally, influenced by off-refuge factors such as up-river diversions for agriculture and municipal use, Lahontan Reservoir operations, and Sierra snowpack and runoff.

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Factors 1-4 appear to have the most influence on the Service's ability to approximate natural biological diversity on Stillwater NWR. Factors 1^{ON}, 2^{ON}, and 3^{ON} are the main on-refuge factors that must be addressed in the comprehensive conserviation plan with respect to fish, wildlife, and plant conservation. Factor 5^{ON} is also addressed in the plan because (a) all public uses of Stillwater NWR that are allowed to continue must first be shown to not measurably impair the Service's ability to approximate natural biological diversity (among other compatibility issues), (b) public use of the refuge is increasing, and (c) addressing nest depredation was identified as an issue of interest to the public.

Because the ultimate causes of Factors 1^{ON}, 2^{ON}, and 3^{ON} originate outside of the proposed refuge boundaries, the comprehensive conservation plan should address the potential of forming partnerships, cooperative management, and other off-refuge Service programs to address them. Not addressing these off-refuge factors (Factors 1^{OFF}, 2^{OFF}, and 3^{OFF}) will hamper the Service's effectiveness in resolving Factors 1^{ON}, 2^{ON}, and 3^{ON}. For example, efforts to resolve insufficient flow volumes through the wetlands (likely the most significant problem facing Stillwater NWR) by only addressing on-refuge factors (Factor 1^{OFF}) will have only limited success because these problems are overridden by inadequate inflow volumes (Factor 1^{ON}). Factor 1^{OFF} is being addressed through an ongoing water-rights acquisition program (USFWS 1996). The program specifically addresses the conversion of waterflow from agriculture and other use back to where the water had originally flowed, the Lahontan Valley wetlands. This factor also is partially addressed in a 1998 agreement between the Bureau of Reclamation, Service, and TCID that outlines a priority system for "excess" water.

The results of the cause-and-effect analysis are discussed in more detail below

1. Hydrology

1^{E} - Effects on Natural Biological Diversity

The major factor that has and continues to affect the natural biological diversity within the proposed boundaries of Stillwater NWR is altered hydrology; e.g., significantly reduced volume (and rate) of water flowing through the lower river and marshes, altered timing of water flowing through these habitats, and pattern of flow through the marshes. Of these, water volume is the most critical.

Some of the components of the natural biological diversity that have been adversely impacted include the number of migratory birds breeding in the wetlands, production of migratory birds and other wildlife, presence and abundance of certain species of invertebrates, overall extent of marsh vegetation, prominence of particular plant communities (e.g., diminished amount of fresh-water plant communities), and successional pathways. The amount of waterfowl use that Stillwater NWR receives during fall and winter is largely influenced by the amount of wetland habitat that is available (Figure 4.1, Volume I, Draft EIS). Prior to the wetlands water-rights acquisition program, available wetland habitat in the Lahontan Valley had declined by an estimated 80-90 percent, as compared to estimated natural conditions. Wetland habitat in the early spring has been especially hard hit. Because use of the wetlands by breeding birds is closely tied to the amount of habitat available during the spring, it is presumed that migratory birds have been significantly impacted.

Although the significant reduction in wetland-habitat acreage is likely the major factor affecting these components of natural biological diversity, the significant reduction in flow rates of fresh water into and through the marsh has likely led to marked changes in marsh ecology and the diversity of species that are seen today. Loss of deeper-water channels running through the marsh has likely impacted native fish and other wildlife by reducing the number of areas that could retain small acreages of water (e.g., low surface area and thus low evaporation) during droughts, although this impact is likely outweighed by the overall reduction in wetland inflows and introduction of nonnative fish.

Table 3. Listing of major problems categorized by ecological zone on Stillwater NWR, Stillwater WMA, and Fallon NWR, Nevada.

Ecological Zone	Major Problems
Marsh	
	1) **Reduced amount and altered distribution and chemistry of water**; including elevated concentrations of dissolved solids and potentially-toxic trace elements in water column;
	2) **Altered geomorphology and soil chemistry**, including absence of deeper channels running through marsh, fragmentation of marsh, absence of one contiguous body of water in Stillwater Marsh, increased salinity/alkalinity of soils, and presence of elements such as mercury in the soil column;
	3) **Altered vegetative composition and structure**, including emergent marsh and shoreline species replaced by salt cedar, presence of shrub component along the edge and interior of marsh (salt cedar), reduced cover of emergent vegetation, increased relative composition of emergent and submergent vegetation associated with higher concentrations of dissolved solids, and low graminoid height along edges of marsh; and
	4) **Prevalence of nonnative fish and wildlife**, including carp, mosquito fish, a variety of game-fish and other nonnative fish species, and bullfrogs.
River & River-Riparian	
	1) **Reduced amount of water in river during all seasons and years and changed chemistry of water**, including reduced volume of water in the river at any give time, absence of perennial water, altered timing of peak water in river, lack of water overtopping [formerly] wet meadow communities, absence of water in side-channels, acreage of wetland habitat, increased stagnation and elevated water temperatures, elevated concentrations of dissolved solids and potentially-toxic trace elements in the water column;
	2) **Altered geomorphology and soil chemistry**, including reduced sinuosity, increased ratio of channel dimensions:water volume (i.e., reduced bank overflow), and presence of toxic elements in the soil such as mercury;
	3) **Altered vegetative composition and structure**, including reduced species richness in plant communities, reduced composition (or absence) of sedges and rushes along river banks, reduced graminoid/forb height, reduced density of grasses, presence of a shrub overstory in wet meadow communities, reduced overstory of tall trees (cottonwoods), and willows, roses, buffalo berry, and cottonwood replaced by salt cedar and Russian olive (e.g., altered composition and structure of shrub layer and tree canopy, and
	4) **Prevalence of nonnative fish and wildlife**, including carp, mosquito fish, a variety of game-fish and other nonnative fish, and bullfrogs, European starlings, and house sparrows (to name a few).
Uplands	
	1) **Altered vegetative composition and structure**, including density of perennial bunch grasses, dominance of underscore by nonnative annual grasses (e.g., cheatgrass), reduced grass/forb height, and dispersed perennial bunch grasses replaced by closely spaced annual grasses; and
	2) **Cessation of movement (replenishment) of sand into dune areas.**
Off-Refuge Conditions	
	1) **Impediments to river flow**, including Lahontan Reservoir, diversion dams, and canals conveying water from the river;
	2) **Degraded habitat conditions** in the Lahontan Valley, along the Carson River, and throughout North, Central, and South America.
	3) **Depressed populations of native fish and wildlife populations** that will not provide an immigration source -- e.g., absence of native fish in Carson River, fragmentation of riparian corridor for movement of riparian-associated small mammals, and reduced populations of migratory bird species, and
	4) **Prevalence of nonnative fish, wildlife, and plant species** that can and will continue to move onto the refuge from surrounding lands, including European carp, various game fish, mosquito fish European starlings, salt cedar, tall white-top, and purple loosestrife

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Results of the cause-and-effect analysis are consistent with contemporary principles of river and marsh ecology and other aspects of biodiversity conservation. Specifically, the reduced volume and altered chemistry, timing, and flow-patterns can significantly alter biological diversity of marsh and riverine ecosystems (Doppelt et al. 1993, Stanley et al. 1997, Ward 1998), which appears to be true also of Stillwater Marsh and the lower Carson River and its delta near Battleground Point.

Several factors have likely led to the reduction in the distribution and canopy cover of cottonwood stands and their understory along the lower Carson River, but the significantly reduced water supply (primarily in terms of frequency of flooding, but also the volume of water and timing peak flows). In other areas, the cessation of the annual flooding and scour cycle of rivers has led to thinning of cottonwood stands and replacement by nonnative plant species (Stalnaker 1999).

Diversity of neotropical migratory birds has undoubtedly been affected by the significantly altered riparian cottonwood communities. About 50 miles away on the lower Truckee River, bird species requiring dense understory of woody riparian vegetation that were common or abundant in 1868 were less common or absent in similar counts made in 1972, 1975, 1976, 1980, and 1981 (Klebenow and Oakleaf 1984). According to the authors of the study, "Shrub and thicket inhabitants that were completely missing from the recent surveys included the Yellow-billed cuckoo, Black-chinned hummingbird, Willow flycatcher, and Yellow-breasted chat (Klebenow and Oakleaf 1984:207). River-channel alterations and conversion to farmland were likely the major factors that adversely impacted riparian vegetation, although livestock grazing was reported as a contributing factor.

Lack of native trees along the lower Carson River and the introduction of exotic species of plants was put forth as the most likely cause of lower-than-expected numbers of bats in this area (Rahn 1999). Cottonwoods are the only native tree of sufficient size to accommodate these bat species. Deteriorated riparian habitat was also identified by Charlet et al. (1998) as impairing higher use of the area by several species of small mammals including desert woodrats, and possibly bushy-tailed woodrats.

1^{ON} - Altered Topography and Restricted Flow through the Marsh

Stillwater Marsh was once one large, contiguous marsh having several deeper channels running the length of the marsh. It is now subdivided into numerous smaller units and the deeper channels have long since filled with sediments. Notwithstanding the restrictions leading to Stillwater Marsh, there are several differences between existing and natural wetland conditions that limit the volume of water that can now flow through the marsh (assuming more inflow is available):

(1) significantly smaller bottlenecks (i.e., small water-control structures compared to comparatively wider spacing between peninsulas and islands);
(2) far fewer spaces between islands and peninsulas (i.e., dikes now span between islands and peninsulas);
(3) flat and nearly flat substrate across wetland units and an absence of sloughs through the marsh (all sloughs have long-since been covered with sediment).

At present, a maximum of only about 450 cfs can be passed through the marsh from several points of entry without damaging water-control facilities and roads, as compared to several thousands of cfs that flowed through the marsh during spring runoff in most years under natural conditions and up to 10,000-20,000 or more cfs during especially high flows. This means that, even with additional water acquisitions and increased conveyance of "excess" water to Stillwater NWR, the refuge could not safely accommodate much more than about 450 cfs. Waterflow through most wetland units of the marsh rarely, if ever, exceeds 150 cfs in high-water events.

High-volume pulses of water during spring runoff were important features of the natural marsh hydrology. They served to flush accumulated salts out of the marsh (thus maintaining a fresher-water system), resuspend deposited sediments and push them through the marsh (thus maintaining deeper-water areas of the marsh and prevented the marsh from silting in), and scour vegetated areas and flatten emergent vegetation (thus creating openings and new channels). Deeper-water channels running the length of the marsh maintained by these high flows allowed the marsh to fill quicker in the winter and early spring and allowed larger volumes of water to pass through the marsh. These processes do not occur or are greatly impaired under existing conditions.

On-refuge flow restrictions are not a problem on the lower Carson River and Battleground Marsh. However, flow volume is significantly restricted up-river (only a maximum of about 1,800 cfs can safely be released from Lahontan Reservoir and a maximum of 800 cfs can be conveyed under the Tarzyn Road bridge.

Management Implications. The most pertinent management implication under this heading is the need to increase the capacity of on-refuge water-control facilities. Obviously, the rate of flow will be ultimately restricted by the amount that can safely be released from Lahontan Reservoir (a small fraction of historic flows into the marsh) and conveyed to Stillwater NWR via Newlands Project canals. Off-refuge flow restrictions are addressed in the next section.

As part of their contract to the Service, Ducks Unlimited currently is ascertaining the feasibility of modifying water control structures, canals, and other water control facilities to increase the volume of water that can be conveyed through different parts of the marsh.

Although the flatness of the marsh certainly limits the flow of water through the marsh, deeper-water channels through the marsh could help offset this factor. Furthermore, upper units would not necessarily have to be filled to deliver water to lower units.

1^{OFF} - Insufficient Amount and Altered Timing of Inflow

Reduced volumes of water flowing through Stillwater Marsh has primarily been a consequence of reduced volumes of water flowing down the lower Carson River, but it also resulted from construction and operation of irrigation canals and drains in the Carson Division of the Newlands Irrigation Project that prevent large volumes of water from reaching the marsh. Whereas natural seasonal-peak flows of the Carson River into Stillwater Marsh were on the order of several thousand cfs upwards to 20,000 or more cfs, the maximum capacity of the canals and drains leading to the marsh is about 450 cfs.

The major factors that have reduced the volume of water flowing down the Carson River into Stillwater Slough, the marshes, and the lower Carson River within the Stillwater NWR Complex are up-river use of water by agriculture, municipalities, and industry, and, related to these, the construction and operation of Lahontan Reservoir for irrigation-water storage and flood control (Thompson and Merritt 1988). Prior to implementation of the water-rights acquisition program for Lahontan Valley wetlands, the average annual volume of water reaching the Lahontan Valley wetlands had declined from an estimated 410,000 AF/year during the late 1800s (Kerley et al. 1993) to just over 40,000 AF/year (USFWS 1996). This is a reduction of about 90 percent. Much of the 410,000 AF estimated to have flown into the Lahontan Valley wetlands flowed through Stillwater Marsh on its way to Carson Sink (roughly 100,000 AF in low water-years to several hundred (possibly up to 600,000 AF or more) in high water-years).

Under the Service's water-rights acquisition program, it is estimated that a long-term average of about 70,000 AF/year of water will reach Stillwater NWR (from as low as 20,000 AF/year to just over 100,000 AF/year). Although this is considerably less than what would flow into Stillwater Marsh under natural conditions, it is a significant improvement over wetland conditions without water-rights acquisitions. This program may very well not have been established if it were not for the support of the Lahontan Wetlands Coalition and the groups comprising the coalition (Poppoff 1993). Although the efforts of the Lahontan Wetlands Coalition and other groups is an "off-refuge" factor, it is directly tied to the activities that individuals partake on Stillwater NWR (on-refuge activities).

There are several reasons why the seasonal pattern of water flowing through the marsh is different than it was under natural conditions. The major factor is the operation of Lahontan Reservoir dam. At present, the dam is operated in accordance with the 1988 Operating Criteria and Procedures (OCAP) for the Newlands Project, as amended in 1997 (USDI 1988, 1997). OCAP provides guidelines that the Newlands Project operator must follow in managing Lahontan Reservoir and the other project facilities. Other factors affecting the timing of water flowing into the marsh include refuge management decisions (delivery schedule and water management), flow restrictions on and off the refuge, use of water by other water users, limitations on when water can be delivered under OCAP, and water-spreading agreements, among many other factors.

Management Implications. Continuation and completion of the water-rights acquisition program may be the single most important Service action with respect to the conservation of Stillwater's wildlife (natural diversity and otherwise).

Modifying Carson Division canals so that higher volumes of water can be conveyed to the refuge, especially during spill-years, would also address the problem of reduced flow rates to the refuge's marshes and rivers corridors. On a related matter, the U.S. Army Corps of Engineers is studying options for reducing flood potential in the Fallon area. Alternatives that would transport greater volumes of flood waters around the City of Fallon and that would convey this water to the wetlands could accommodate the City of Fallon's objectives as well as those of the Service. Furthermore, any additional water conveyed to the refuge during spill years could reduce the amount of water to be acquired from other sources.

Adherence to criteria in the "Excess Water" agreement should ensure that the refuge receive a portion of water that is released or spilled from Lahontan Reservoir during precautionary releases and spills. This will likely require constant attention during years of precautionary releases and spills.

2. Nonnative Species

2^{E} - Effects of Nonnative Species on Natural Biological Diversity

Another major factor impacting natural biological diversity within the Stillwater NWR Complex is the introduction, continued influx, prevalence, and spread of certain introduced plant species (e.g., saltcedar in riparian and marsh habitats, and cheatgrass in uplands) and animal species (e.g., bullfrogs, European carp, and other fish in marshes, and cattle and European starlings in riparian areas). Worldwide, the introduction of nonnative species is one of the leading causes of degradation of natural biological diversity (Bryant and Barber 1994, Hunter 1996). Impacts of nonnative species on natural biological diversity can be divided into two main groups: (1) effects on plant community composition and structure, and effects of these alterations on native animal species; and (2) effects on animal populations through competition, predation, and disease. The first group can be further divided into two categories: (a) effects of nonnative plants on plant community composition and structure through competition; (b) effects of nonnative animals on native-plant community structure through direct impacts (e.g., reducing grass height and canopy cover, due to cattle grazing); and (c) effects of nonnative animals on plant-community composition and structure through indirect impacts (e.g., reduced cover of native plant species leading to increased cover of nonnative species, due to cattle grazing; increased turbidity of water leading to reduced cover of aquatic vegetation, due to carp feeding). Categories 1a, 1b, and 2 are addressed in more detail below. Category 1c effects are addressed further in the following section, 2^{ON}, as these are indirect impacts to natural biological diversity.

Charlet et al. (1998) concluded that the most serious single problem with the vegetation in Stillwater NWR/WMA and Fallon NWR is the introduction, naturalization, and increased abundance of exotic species, with saltcedar being the primary species they discussed. Saltcedar has a significant impact on some plant communities within the Stillwater NWR Complex. For instance, vast areas of meadow

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habitat dominated by grasses, rushes, and sedges has converted to saltcedar dominated communities with little underscore. Monotypic stands of saltcedar is replacing mixed deciduous shrub/tree communities in riparian areas and emergent vegetation in marshes. These observations are consistent with studies from other locations (e.g., Busch and Smith 1995, Vitousek 1986). The alterations to natural plant community composition and structure has likely had marked impacts to wildlife communities.

Altered structure of native plant communities due to cattle grazing adversely impacts several components of natural biological diversity. This has been thoroughly reviewed in Appendix M (DeLong 2000). It directly alters the natural structural diversity of vegetation. Cattle grazing reduced the height and stature of native grasses, rushes, and forbs in meadow and riparian communities. This has shown to affect native bird and small mammal communities, as summarized in Appendix M. This was also addressed in Charlet et al. (1998). Cattle grazing also can reduce the height of deep-emergent communities and thus affect wildlife communities.

Cheatgrass is having considerable impacts to native plant communities in some upland areas of the refuge. Cheatgrass produces extensive ground cover in areas previously characterized by large proportions of open ground. This could impact species requiring spacing between plants, such as kangaroo rats (Price and Brown 1983 and Reichman and Price 1989, as cited by Longland 1993) and lizards. Another attribute of cheatgrass-dominated communities is their propensity for frequent burning. This would have devastating impacts to native salt-desert shrub communities that evolved with very infrequent fires (Young and Tipton 1990). Being an annual, cheatgrass thrives under frequent burning.

European carp, brown bullhead, smallmouth bass, mosquito fish, and other non-native fish dominate the fish communities within the proposed refuge boundary. A total of 29 species of fish have been documented on Stillwater NWR, of which three are native and one of these has not been documented for about 20 years. In addition to this overwhelming effect on natural biological diversity, European carp can have indirect adverse impacts on native biotic communities by increasing water turbidity and markedly reducing aquatic plant production (Moyle et al. 1986; Unpublished data, U.S. Fish and Wildlife Service, Malheur NWR, Oregon), and thus wildlife communities in Great Basin marsh ecosystems. Based on a thorough review of the scientific literature and their observations at Ruby Lake NWR, just to the east of Stillwater NWR, Bouffard and Hanson (1997) suggested that introductions of exotic fish alters native aquatic communities, influences nutrient dynamics and productivity, and modifies natural food webs in many wetlands. Of native North American species, 34 percent of fish and 74 percent of unionid mussels are at risk due to nonnative fish introductions (Wilcove et al. 1992, as cited by Bouffard and Hanson 1997). Several species of game fish inhabiting Stillwater NWR Complex have been shown to significantly affect populations of amphibians in other areas due to predation on eggs, larval, and adults, as well as a variety of indirect effects (Maxell and Hokit 1999). Smallmouth bass, which have been common in Stillwater Marsh in the past, can adversely impact waterfowl broods. Williams (1999) noted that "Almost everywhere introduced mosquitofish have harmed aquatic ecosystems and faunas because of their highly predaceous habits, and they have reduced or eliminated populations of at least 20 other species of fish, including largemouth bass (Schoenherr 1981) and numerous invertebrate species." Mosquitofish do not only feed on mosquito larvae, the reason for which they have been introduced into countless water bodies, but they also eat other invertebrates and can prey on eggs and fry of other fish, eggs and tadpoles of frogs (Webb and Joss 1997, for study and additional citations).

Bullfrogs, a nonnative invasive species that is common to abundant in some wetlands within the Stillwater NWR/WMA and Fallon NWR area, have been shown to significantly alter amphibian diversity in other areas and have been implicated in the declines of several species of amphibians and reptiles (e.g., Bury and Whelan 1984, Rosen et al. 1995, Kupferberg 1997, and Lawler et al. 1999; as cited by Maxell and Hokit 1999). Adults bullfrogs are well known for preying on amphibians during all three life-history stages and on smaller aquatic reptiles, but larval bullfrogs also prey on eggs and larvae of native amphibians (see Maxell and Hokit for review). Furthermore, as summarized by Maxell and Hokit (1999), "eggs, larval and adult amphibians are also likely to be indirectly affected by the threat of

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predation due to (1) adult avoidance of oviposition sites where predators are present (e.g., Resetarits and Wilbur 1989), (2) decreased larval foraging and, therefore, growth rates as a result of staying in refuges to avoid predators (e.g., Kiesecker 1997 and Kiesecker and Blaustein 1998), and (3) decreased adult foraging and growth rates as a result of avoiding areas with bullfrogs." Thus, bullfrogs may be a contributing factor to the marked decline in leapord frog populations in the Lahontan Valley and may be one reason why Western toads have not been recorded on the Stillwater area (E. Simandle, University of Nevada-Reno, personal communication, 1999). Bullfrogs could potentially be impacting the existing population of spade-foot toads as well.

Introduced to North America in 1890 (Chapman 1924), European starlings have had significant adverse impacts on native cavity-nesting birds throughout North America. European starlings are aggressive competitors and likely have significant impacts on the ability of native cavity-nesting birds (e.g., wood ducks, American kestrels, northern flickers) to find suitable nesting sites along the lower Carson River. Havera and Kirby (1988) noted that competition with starlings for nest sites is a continuing problem for wood ducks, citing Heusmann and Bellvilie 1982). In Maine, starlings were found to be the leading cause of nest abandonment in wood ducks (Allen et al. 1988). Starlings appear to have similar impacts in the Lahontan Valley (N. Saake, Nevada Div. of Wildl., personnal comm. 1995).

Although domestic cats do not appear to be a problem on the refuge at present, the potential for this could increase in the future with increased urbanization outside of the proposed refuge boundary, especially to the southwest (lower Carson River area). Domestic cats can have significant impacts on some taxa of native wildlife.

2^{ON} - Presence and Spread of Nonnative Species

The major factors that have contributed to the spread of saltcedar within the proposed boundaries of Stillwater NWR include large seed source, suitable water conditions in previously unoccupied habitant, and heavy to severe cattle grazing. The saltcedar population on Stillwater NWR/WMA, Fallon NWR, and the surrounding area is high. Each saltcedar plant can produce thousands of seeds. Saltcedar requires surface soil moisture for a long enough period to germinate and extend its tap root to a more reliable water supply. The highly dynamic nature of Stillwater's wetlands provides ideal conditions for saltcedar germination. (Appendix J)

Cheatgrass and halogeton along roadsides are common on Stillwater NWR/WMA and Fallon NWR, and thus roads pose a way for cheatgrass to continue to expand in distribution on the area (Charlet et al. 1998).

Introduction and continued grazing by cattle is one of the most pervasive influences on riparian, meadow, and shoreline habitats. Possibly one of the most severe impacts of cattle grazing is the influence that it has on the influx and spread of other nonnative species, such as saltcedar and cheatgrass. Native plant communities impacted by diminished water availability and excessive cattle grazing likely have been key contributors to the spread of saltcedar in the Stillwater area.

Management Implications.

Two major, yet basic management implications pertaining to the above discuss is the control of saltcedar spread and the control of cattle grazing. A saltcedar control plan was recently completed for Stillwater NWR (Appendix J). As yet, controls over cattle grazing is limited, but this is being addressed in the CCP process.

Extension of the approved boundary of Stillwater NWR to include the lower Carson River would provide opportunities to restore the riparian corridor, through restoration on Federal lands (to the extent that lands are acquired from willing sellers) and cooperative efforts with private landowners and other agencies.

Based on the purposes of the refuge and other legal mandates, no attempts should be made to control mosquitos on the refuge. However, if any measures are undertaken to address mosquito concerns (e.g., mosquito abatement) the introduction of mosquito fish should be avoided, as they are nonnative to the area and can have impacts on communities of native fish and invertebrates.

No solutions have been found to effectively curtail the competition that starlings have on wood ducks (Heusmann and Bellville 1982, as cited by Havera and Kirby 1988) and other native cavity-nesting birds. Unfortunately, this can also be said for the adverse effects caused by many other nonnative wildlife species, including a host of nonnative fish that enter the refuge via drains and canals and bullfrogs.

2^{OFF} - Continued Influx of Nonnative Species

For many — possibly all — of the nonnative species impairing the approximation of natural biological diversity within the Stillwater NWR Complex, continued influx of seeds, eggs, young, and adults maintains a significant, never-ending impairment to controlling nonnatives species. All of the major nonnative species present today will remain part of the refuge's biological community.

Seeds of saltcedar, perennial pepperweed, and other nonnative species associated with marsh, shoreline, and riparian areas will continue to flow into the refuge. Some seeds, such as those of saltcedar, arrive via winds (i.e., they are airborn). Purple loosestrife has not been documented in the refuge, but occurs up-river. Thousands of acres of cheatgrass adjoin the refuge, and there are millions of acres beyond this.

European carp, mosquito fish, brown bullhead, various species of sunfish, smallmouth bass, and others enter the refuge as eggs, fry, young, and adults through the irrigation canals, drains, and river entering the Stillwater NWR. Screening efforts, in other areas, to exclude these types of fish have only had limited success. Bullfrogs can enter the refuge as larvae and as adults.

Any vacancies created by European starling control efforts would quickly be filled by a burgeoning starling population in the Lahontan Valley. Domestic cats and dogs, if found to be a problem on the refuge, could likely be successfully controlled. Because livestock are allowed on the refuge through permit only, the influx of cattle, horses, and other livestock can be tightly controlled.

Management Implications. One of the best opportunities for partnerships with surrounding landowners would be a concerted and coordinated effort to reduce the distribution and spread of saltcedar and to control perennial pepperweed and purple loosestrife before they gain a foothold in Lahontan Valley. Such efforts could potentially reduce the volume of seeds entering the refuge, thus facilitating on-refuge control efforts.

Screening and other techniques to prevent, or at least minimize, nonnative fish from entering the refuge should be explored. However, this is expensive and labor intensive.

3. Contaminants

3^{E} - Effects on Stillwater NWR's Natural Biological Diversity

Stillwater NWR is impacted by several environmental stressors. The combined effects of these stressors has contributed to the degradation of the system as a whole. Due to the similarity of the end results of many of these stressors and the length of time that the impacts have persisted, it is difficult to ascertain the relative contribution of each stressor to effects to habitat quality or fish and wildlife populations on the refuge. A variety of environmental contaminants have been identified in water, sediment, and

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biological samples from Stillwater NWR. Metals and other trace elements appear to represent the greatest threat to fish, wildlife, and habitat quality on Stillwater NWR.

A reconnaissance investigation of wetlands in and near Stillwater NWR was initiated in 1986 to determine if agricultural drainage had caused, or had the potential to cause adverse effects to human health, fish and wildlife, or affect the suitability of water for beneficial uses (Hoffman et al. 1990). Concentrations of some potentially-toxic elements (e.g., arsenic, boron, dissolved solids, sodium, and un-ionized ammonia) were found to be in excess of Federal and State criteria for the protection of aquatic life and propagation of wildlife. Sediment from some affected wetlands contained elevated levels of arsenic, lithium, mercury, molybdenum, and zinc. Additionally, concentrations of arsenic, boron, copper, mercury, selenium, and zinc in biological tissues collected from some affected wetlands exceeded levels associated with adverse biological effects in other studies. This study concluded that arsenic, boron, mercury, and selenium were of primary concern to human health and fish and wildlife in and near Stillwater NWR. Subsequent investigations have generally supported the findings of the reconnaissance investigation (Lico 1992; Hallock and Hallock 1993, Tuttle et al. 1996; Lico and Pennington 1997). Although concentrations of potentially-toxic elements have been found to be in excess of Federal and State criteria, documentation of detrimental impacts to wildlife are few.

The potential for impacts of agricultural chemicals to fish, wildlife, and habitat quality on Stillwater appears to be low. Although a variety of pesticides have been identified in drain water entering the refuge, detected concentrations were generally below levels of concern (Lico and Pennington, 1997). However, it should be noted that the sporadic use of pesticides, combined with the limited sampling and short life of many pesticides in the environment make identification of problems difficult. Therefore, agricultural chemicals can not be eliminated as a concern on Stillwater NWR.

3^{ON} - Unnaturally-high Concentrations of Contaminants in Wetland Waters and Soils

Contaminants are a recognized problem at Stillwater NWR, and the source of the contamination can be divided into two major groupings: (1) naturally occurring elements that have become concentrated due to human activities, and (2) contaminants that have been introduced through human activities. Of major concern in the first group are aluminum, arsenic, boron, copper, selenium, and zinc. Of major concern in the second group is mercury. For the purposes of this report, unnaturally-high concentrations of salts and alkalinity in wetland inflow are not considered contaminants. Rather, inflow that has significantly higher salinity and alkalinity than natural inflows is simply viewed as hindering or preventing the Service from providing fresh-water wetland habitat, thus hindering the approximation of the natural biological diversity associated with this habitat.

Several studies have documented concentrations of several elements in excess of Federal and State criteria. These are summarized in the preceeding section. Mercury concentrations in sediment, vegetation, vertebrates, and invertebrates have been found to be above acceptable thresholds in several wetland units within the Stillwater NWR Complex, including the Carson River.

Management Implications:

Concerns with contaminants in the first group would be reduced to the extent that contaminant concentrations in wetland inflows (3^{OFF}) were reduced. Lower water-borne concentrations would reduce deposition in wetland soils, food chain incorporation, and ultimately fish and wildlife exposure. Additionally, most elements in this group are water-soluble. Therefore, flushing would promote the gradual reduction of concentrations in wetland soils, at least in higher gradient wetlands (3^{ON}) Water management on the refuge, specifically, regular flushing of wetlands, would alleviate concerns to a lesser degree.

Unnaturally high concentrations of mercury in wetland soils is a chronic problem on the refuge that cannot be easily remedied. Mercury has a high affinity for wetland soils. Therefore, water management practices, such a flushing, will not be effective in reducing existing contamination. Conversely, mercury is mobilized from river banks and flood plains during upstream flood events. Therefore, using flood water to flush wetlands could, during exceptionally large upriver floods, increase the rate of transport of mercury to the refuge thereby exacerbating existing contamination. The natural hydrologic pattern of Stillwater Marsh may also increase the potential for adverse effects. Research has found that alternating cycles of desiccation and reflooding of wetland soils may promote conversion of mercury to chemical forms that are more biologically available and more toxic. Efforts to identify remedial and/or management options to reduce the threat of mercury to fish, wildlife, and their habitat are underway. The first goal of this research is to reduce continued mercury transport to refuge (3^{OFF}). Other options to reduce mercury exposure will also be evaluated.

3^{OFF} - Inflow of Unnaturally-high Concentrations of Contaminants

In most years prior to the water-rights acquisition program, the only water reaching the wetlands was agricultural drainwater. This resulted in much higher concentrations of dissolved solids than had occurred under natural conditions (e.g., an estimated 1,700 mg/l versus less than 300 mg/l) and elevated concentrations of toxic elements entering the wetlands. Several studies have shown that elevated TDS concentrations of wetland inflows have a corresponding increase in potentially-toxic elements. The ongoing water-rights acquisition program will contribute substantially to addressing this problem. It is estimated that, at the completion of the acquisition program, the average TDS concentration of wetland inflow will decline to an estimated 300-400 mg/l. One factor not readily apparent in these numbers is that, at any given TDS concentration today, the concentration of some potentially-toxic elements is higher than they would have been under natural conditions. This is due to elevated amounts of these elements entering waterways from agricultural, municipal, industrial, and other land-use practices.

Mercury initially was introduced to refuge wetlands during the late 1800s and early 1900s during the Comstock gold-mining era, prior to full development of the Newlands Irrigation Project. Significant deposits of mercury remain throughout the Carson River system below Carson City. Each major flood results in resuspended mercury, an unknown portion of which passes through Lahontan Reservoir to the Carson Division of the Newlands Project and eventually to refuge wetlands.

Management Implications:

Continuation and completion of the Lahontan Valley wetlands water-rights acquisition program will likely have the most marked positive impact to the wetlands with respect to contaminant problems. Curtailment of the acquisition program would have serious consequences to resolving contaminant issues on the refuge. All other potential solutions would require coordination or action by other agencies, businesses, and the general public, as they would necessarily be conducted outside of the refuge.

The acquisition program does not address the problem of high concentrations of mercury entering refuge wetlands during major flood events on the Carson River. Potential solutions are being explored to reduce this continued threat to wetland ecosystems. Options, all of which would require action of or coordination with other agencies or other entities, include a change in the management of controlled releases from Lahontan Reservoir dam during floods or removal of mercury from Carson River water during flood events.

4. Altered On-refuge Abundance Due to Off-refuge Land-use Practices

4^E - Effects on Stillwater NWR's Natural Biological Diversity

The previous factors addressed the effects of on-refuge habitat conditions on native plants and animals using the refuge, and the ultimate causes of degraded habitat conditions. This factor addresses off-refuge conditions that affect the overall abundance of native plant and animal species that would have used the refuge area under natural conditions. Altered populations of native plant and animal species affect the biological diversity of Stillwater NWR directly because the richness of species (identity and number of species) and abundances of these species are the major components of biological diversity (Noss and Cooperrider 1994, DeLong 1996).

4^{ON} - Altered Populations on Stillwater NWR

The diversity of birds on Stillwater NWR is affected by land-use practices throughout the Western Hemisphere. Many species of birds that use Stillwater NWR only spend part of their time on the refuge. Therefore, although habitat quality on Stillwater NWR plays a large role in determining the level of use by any given species, the overall population size of the species in the Pacific Flyway also is a dominant factor affecting abundance on the refuge. For instance, if a particular species or given population of a species is low, its abundance on Stillwater NWR will correspondingly be low, regardless of habitat quality on the refuge.

Other land-use practices have benefitted certain species using Stillwater NWR, such as white-faced ibis and possibly common ravens. Ethnographies of local Indians and other historical accounts suggest that bighorn sheep and pronghorn occasionally visited the area encompassed within the proposed refuge boundary. Since Euro-American settlement of the Lahontan Valley, use of the area by these species has stopped.

4^{OFF} - Off-refuge Land-use Practices

Some species of migratory birds have been adversely impacted by reduced habitat quality and availability in North America. Other species have been adversely impacted by declining habitat availability and continued use of pesticides in Central and South America.

Surrounding land-use practices (flood irrigation) appear to have increased the white-faced ibis population (Fowler 1992), but this assumes that adequate nesting habitat remains available on Carson Lake and Stillwater NWR. Fowler (1992). Thus, it is possible that use of the refuge complex by white-faced ibis is higher now than it was prior to agriculture in the Lahontan Valley.

Although additional investigation is needed, it is hypothesized that the common raven population in the Lahontan Valley is higher now than it was prior to the mid 1800s likely due to increased availability of food during critical seasons as a consequence of land fills, ranching, dairy farms, and other agricultural practices (carcasses); and an extensive road and highway system (road kills). Based on results of the North American Breeding Bird Survey (Sauer et al. 1999), the raven population throughout the Great Basin increased significantly between 1966 and 1998 ($P=0.08$). No direct comparisons can be made between existing population of ravens inhabiting the Lahontan Valley and the population level that existed prior to the mid 1800s, but a wealth of information on raven ecology and comparisons of existing and natural ecological conditions could be used to further examine this issue. Based on the results of three other studies (Boarman 1993, as cited by Boarman and Berry 1995) reported that elevated raven populations in the southwest are a result of human subsidies (e.g., solid waste landfills, agricultural products, powerlines).

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Management Implications:

A major management implication under this factor is that managers and the public must recognize that the abundance of native species on the refuge at any given time is in part influenced by the overall population level of the species or population that uses the refuge. Another management implication is that special measures may have to be taken outside the scope of restoring natural habitat conditions to benefit certain native species whose populations are critically low as compared to natural conditions. This could possibly include the control of certain other native species that are demonstrated to have significantly higher populations than naturally occurred and that could be having undue impact on them.

5. Altered Disturbance and Mortality/Production

This section involves two main issues: effects of human disturbance, and the effects of changed predator populations and the potential effects on prey populations.

5^E - Effects on Natural Biological Diversity

Public use on Stillwater NWR/WMA and Fallon NWR has influenced wildlife and their habitat in two primary ways: (1) by contributing to an increase in much needed water for the refuge's wetlands, and (2) affecting the behavior, activity patterns, distribution, habitat use, and related parameters. Increasing the amount of water flowing into the wetlands will contribute to resolving the problems identified in Factor 1, which addresses the most critical issue facing Stillwater NWR (water). If it were not for the support of people using the refuge for hunting, birdwatching, and other activities, it is quite likely that drainwater would continue to be the sole source of water in most years (thus contributing to resolving problems identified in Factor 3). The factor discussed in this section (Factor 5) addresses the second way that public use influences wildlife and habitat on Stillwater NWR/WMA and Fallon NWR. Human activity on Stillwater NWR can influences the Service's ability to achieve refuge purposes. A review of the scientific literature revealed that the effects of human activity include minor disruptions in wildlife behavior, changes in distribution and habitat use, reduced abundance, impaired productivity, altered nutritional status, premature departures from areas during migration, and increased mortality (DeLong and Schmidt 2000). An analysis of 30 years of waterfowl surveys conducted on Stillwater NWR and other Lahontan Valley wetlands indicates that waterfowl hunting and associated activities has had an effect on waterfowl distribution and habitat use on Stillwater NWR (Bundy 2000).

The effects of human activity in wildlife habitat can be divided into six categories, as defined by Purdy et al. (1987) in their paper on human disturbance to wildlife on national wildlife refuges: (1) direct mortality: immediate, on-site death of an animal; (2) indirect mortality: eventual, premature death of an animal caused by an event or agent that predisposed the animal to death; (3) lowered productivity: reduced fecundity rate, nesting success, or reduced survival rate of young before dispersal from nest or birth site; (4) reduced use of a refuge: wildlife not using the refuge as frequently or in the manner they normally would in the absence of visitor activity; (5) reduced use of preferred habitat on refuge: wildlife use is relegated to less suitable habitat due to visitor activity; (6) aberrant behavior/stress: wildlife demonstrating unusual behavior or signs of stress that are likely to result in reduced reproductive or survival rates.

These factors, some of which were listed in Table 1, can alter biological diversity on the Stillwater NWR Complex. Applicable components of biological diversity including species richness (identity and number of species); abundance and distribution of wildlife (including habitat-use and use-days on the refuge); and biotic processes, such as migration and movement patterns (e.g., arrival and departure dates), feeding patterns and nutritional status, and production and survival rates. Related effects include the extent to which hunted species can find secure areas in high quality habitat for feeding, resting, and thermal regulation. DeLong and Schmidt (2000; Appendix L) describe these potential effects in detail. The potential effects of the proposed public use program on the various components of natural biological

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diversity and other aspects of refuge purposes are detailed in Appendix O. The scientific information presented in the "Anticipated Impacts of the Use" column (the information of which was derived primarily from DeLong and Schmidt 2000) of the worksheet at the end of Appendix O (pages 81-92) summarizes the information on the potential impacts of hunting and supportive activities (e.g., boating) on the various components of natural biological diversity and other Stillwater NWR purposes.

Another potential factor is altered depredation rates of waterbird nests due an elevated common raven population (see Factor 4, above). Although no direct information is available to demonstrate that depredation of waterbird nests is unnaturally high, but an initial examination of available information (see Factor 4) suggests that the raven population is higher than it was under natural conditions, and, given the great efficiency at which ravens can locate nests, it is hypothesized that depredation rates of waterbird nests is higher than occurred naturally. Boarman and Berry (1995) cited several studies in which common ravens, a native species in all of the cited study areas, was having serious impacts on other native wildlife species, due to the significant increase in raven populations which in turn has been the result of human alteration of the local ecosystems. At this time, site-specific information does not exist to indicate whether nest depredation or mortality rates are any different on Stillwater NWR than they would be under natural conditions. Additional investigation is needed.

5^{ON} - Human Disturbance Rates on the Refuge

Past and ongoing human activities that result in wildlife mortality or disturbance to wildlife (e.g., driving, boating, hunting, fishing, muskrat trapping, wildlife viewing, camping, activities of refuge personnel) can affect biological diversity on the Stillwater NWR Complex as briefly noted above. The extent of effects are dependent on how the public use program is designed and individual public uses are managed.

Existing Public Use Program: Outside of national laws, State and Federal hunting regulations, and a sanctuary, there are few restrictions on wildlife-dependent recreational uses and other uses on Stillwater NWR and Stillwater WMA. The open area (non-sanctuary) is open to public use 24 hours per day, 7 days per week; there are no restrictions on the number of people using the marsh or other habitats; and, although vehicles are restricted to open roads, the road network is extensive and people are permitted to walk and boat throughout the entire open portion of the marsh year-round. The entire area is closed to off-road vehicle use, but, despite this restriction, off-road vehicle use continues in some areas, especially in the sand dunes. Camping is permitted throughout the area, although little camping occurs outside of the Indian Lakes area during the summer and in the area of Stillwater Marsh during the waterfowl hunting season. The sanctuary, which is closed to all public access, has remained in the same place since 1949. Nearly half of the sanctuary consists of the refuge's regulating reservoir. The sanctuary traditionally has encompassed 30-60 percent of the available wetland-habitat in Stillwater Marsh (although no minimum has been established).

Hunting is permitted throughout the open area (i.e., up to 72 percent of Stillwater Marsh), all day, seven days per week, and boats, including airboats, are allowed on all wetland units with few restrictions. Although hunting pressure has been light to moderate during the past few years, due to reduced interest after an eight-year drought and extensive acreage after five spill years, hunting density and pressure is anticipated to increase as wetland-habitat becomes more reliable. An estimated 20 percent of hunters used boats in the 1999-2000 season (Chaney 2000). In the 1970s, when the hunt area regularly exceeded 10,000 acres of wetland-habitat, hunter densities of 1 hunter per 30 acres was not uncommon. Hunter numbers may not return to what they were in the 1970s, but hunter densities can. There is no minimum amount of sanctuary that must be provided during the hunting season under the existing program and during the past 10 years, the amount of the amount of sanctuary provided has varied considerably. Generally, when less than 3,000 acres of wetland habitat exists during the hunting season, roughly 50-65 percent of the habitat was provided in sanctuary. When total wetland-habitat acreage is between 4,000 and about 10,000 acres, about 35-40 percent of the habitat was in sanctuary. Above 11,000 acres of wetland-habitat, less than 30 percent was in sanctuary.

Development of a Problem Statement:

Enactment of Public Law 101-618 in 1990 and the National Wildlife Refuge System Improvement Act in 1997, and the new requirements they contain for Stillwater NWR resulted in a shift in the management authorities governing the management of the Stillwater NWR. Until the comprehensive conservation plan is approved and implementation begins, Stillwater NWR will continue to be managed under most provisions of the 1948 Tripartite Agreement. Under this agreement, hunting has been the priority public use and it has had coequal status with wildlife conservation. Many other recreational activities have been allowed on Stillwater NWR, Stillwater WMA, and Fallon NWR, including fishing, wildlife observation and photography, camping, boating, and horseback riding.

The direction provided in Public Law 101-618 and the Refuge System Improvement Act is clear: the conservation of native fish, wildlife, plants, and their habitat is the fundamental mission of Stillwater NWR. As articulated in the Service's *Fulfilling the Promise* document (USFWS 1999), "...the law of the land now clearly states that their needs [fish, wildlife, and plants] must come first..." It is also clear that another very important goal of Stillwater NWR is to provide opportunities for compatible wildlife-dependent recreation. Just as the Refuge System Administration Act calls for refuge managers to facilitate opportunities for wildlife-dependent recreation, it requires managers to make sure that these and other such uses are compatible with refuge purposes before they are permitted. The Act notes that hunting, fishing, wildlife observation and photography, and environmental education and interpretation have generally been found to be compatible uses of the Refuge System. The Act recognizes, however, that not all of these uses will be found compatible on all refuges. This is illustrated by an example provided of Blackwater NWR, Maryland, in which hunting is not permitted (House Report 105-106). Some refuges do not provide any public access.

The Act also recognizes that, although a use may be identified as generally compatible on a given refuge, whether it is actually compatible depends on how the program for the use is designed and operated. The design of the existing public use program reflects the philosophy of the 1948 Tripartite Agreement. The current planning process has entailed evaluating and designing a public use program according to the standards set by Public Law 101-618 and the Refuge System Improvement Act.

The disagreements that the shift in management authorities has stirred, especially with respect to hunting on Stillwater NWR, warranted a closer examination. Given the many factors involved, a flow chart was developed to assist in explaining the basis of the underlying problem that the Service must address in the planning process with respect to the public use program and its compatibility during the hunting season (Figure 3). This chart addresses factors beyond the scope of natural biodiversity; the other purposes of Stillwater NWR were also addressed. This underlying problem is summarized as follows:

> Under the existing public-use program, there are insufficient provisions to (1) ensure that providing for the needs of wildlife is not being impaired, and (2) provide suitable opportunities for environmental education and wildlife viewing outside the hunt area during October-December.

Many factors are involved, including the change in management authorities governing the management of the area, biological and scientific information, professional judgement, and other input received during the scoping process. The first item in the problem statement involves three main interrelated factors: (1) boating and road access, (2) hunter density and distribution, and (3) amount and quality of sanctuary. During the past several years, hunter densities on Stillwater NWR have been relatively low, and it is generally recognized that a low density of hunters affects waterfowl and other wildlife less than a high density of hunters (DeLong and Schmidt 2000, for review).

Sanctuary is not as high of a concern if hunter density is low enough to allow waterfowl to find high-quality habitat in relatively undisturbed areas outside the sanctuary. However, even a few airboats and other motorized boats can counteract low hunter density, meaning that more sanctuary would be needed to ensure that birds can readily access high-quality habitat in a relatively undisturbed area. Extensive published scientific information summarized by DeLong and Schmidt (2000; Appendix L) suggests that the effects of liberal boating in Stillwater Marsh during the hunting season may have as much or more to do with altered waterfowl distribution and habitat use during the hunting season (Bundy 2000) than the effects of hunting by itself. Boating effects wildlife in three main ways: speed, noise, and increased access into all habitats open to boating. With few boating regulations, the demonstrated effects that even small numbers of boaters can have on wildlife, and the vast majority of wetland-habitat open to boating on Stillwater NWR, there are few assurances that waterfowl and other wildlife will not be unduly impacted. Road access is another factor influencing hunter distribution and density. There are several concerns related specifically to the adequacy of the existing sanctuary, and these are discussed further in Appendix O. The effects of boating, hunting, wildlife observation, and other activities are addressed in Appendix L and compatibility determinations (Appendix O), and therefore are not discussed in detail here.

The second part of the underlying problem addresses environmental education and wildlife observation. Service policy requires that environmental education sites be provided outside the hunt areas, which is highly pertinent to Stillwater NWR as environmental education is the only priority public use specifically identified in refuge purposes. At present, there are no places outside the hunt area for people to view birds or for the Service to take school groups and other groups during the hunting season, except one small parking area next to the maintenance shop. Although several individuals and groups have commented that this is not a problem because combined use of the same area tends to maintain unity and cohesion among the different user groups, other people have expressed that they would like opportunities to be provided outside the hunt area during the hunting season.

Management Implications:

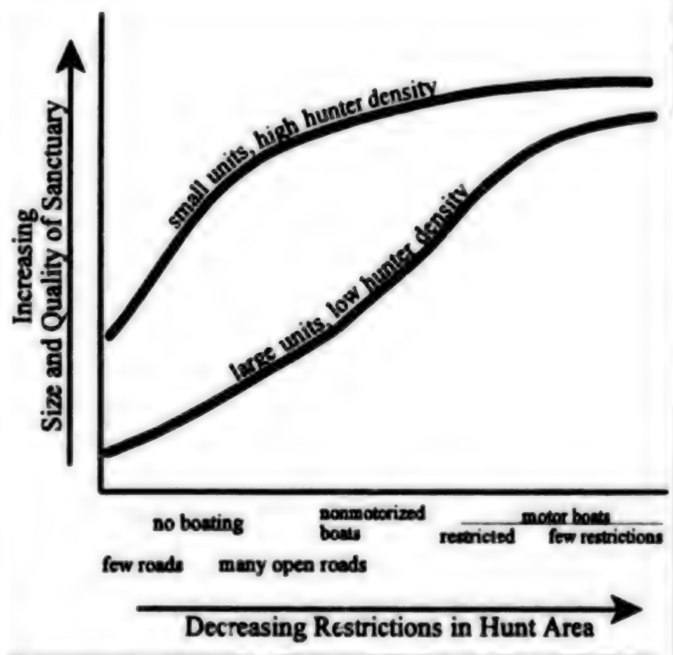

Figure 4. Graphic illustration showing the general relationship between the level of restrictions in a hunt area and the amount of sanctuary needed to counterbalance the effects of disturbance, assuming wildlife welfare is the highest priority, under two different scenarios.

Effects of human activity on Stillwater NWR are directly influenced by the way in which public uses are managed on the refuge, including adjustments that can be made to account for increased or decreased numbers of visitors. Because information on site-specific impacts of human disturbance is limited, the biological program must be reassessed to better account for this issue. Furthermore, adaptive management, combined with explicitly stated success-criteria and thresholds, must be a key part of the comprehensive conservation plan.

Figure 4 graphically illustrates the relationship among the effects of boating (and other modes of accessing the marsh), hunter density, and the amount of sanctuary needed (the figure represents a conceptual synthesis of pertinent information contained in DeLong and Schmidt 2000). These factors must be weighed in developing a hunt program that is compatible with Stillwater NWR purposes. Generally

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illustrated is that the need for sanctuary is somewhat lower for an area comprised of large wetland units with relatively low hunter density as compared to an area comprised of many small wetland units and many hunters, although the allowance of airboats and other motorboats would tend to equalize the effects. Even though hunter density is low to moderate on Stillwater NWR, relatively unrestricted boat access has the potential to offset this factor.

Therefore, under anticipated average water conditions (or better) and assuming relatively low hunter densities, the issue in many ways boils down to a relationship between the level of boating restrictions and amount of sanctuary (Figure 4). The more liberal the boating regulations are, the more sanctuary is needed. Conversely, the more that boating access, speed, and noise are minimized, the lower the needs are for sanctuary. In wetland areas allowing boating access, the most effective way to mitigate for the adverse impacts of boating is to provide areas of high-quality habitat that are inviolate to boating (Havera et al. 1992). Other ways to reduce the adverse effects of boating include overwater speed limits and no wake restrictions (to minimize speed) and limits on decibels of noise produced by motorboats and limits on the horsepower of motorboats, also to reduce noise output. Limitations on horsepower may or may not reduce noise produced by motorboats because some motors do not have mufflers.

Altered Production/Mortality Rates:

A related issue, not addressed in Appendix L (DeLong and Schmidt 2000), is the extent to which populations of predatory species have changed and how altered populations of these species have affected the productivity or survival of their prey species on the refuge. Again, very limited site-specific information exists for the refuge and additional information is needed (however, see previous discussions of ravens). To the extent that raven populations are higher, depredation of waterbird nests may be higher than it would be under natural conditions, regardless of nesting-habitat quality. This was not identified as a core problem because alterations to wildlife habitat likely are more important factors influencing waterbird production. Furthermore, off-refuge land-use practices and activities (land-fills, agriculture, livestock production [livestock carcasses], roads and highways [roadkills]) likely are the underlying causes for any population changes. Furthermore, on-refuge activities may contribute to elevated depredation rates by common ravens. Although ravens are highly effective at locating nests from the air (personal observ.), elevated perches near waterbird nesting areas increases their efficiency at finding nests. Therefore, directional signs along roads, spoil piles along canals, possibly satlcedar, and other things providing elevated perches would appear to contribute to any elevations in nest depredation. Human activity (e.g., recreators and refuge staff) in areas of waterbird nesting can also assist ravens in locating nests due to incubating birds being flushed from nests (see DeLong and Schmidt 2000 for review).

5^{OFF} - Public Interest in Using Refuge (local-global) and Altered Populations of Predators

Populations of Fallon, Fernley, Reno, and Carson City are growing and visitation by other nearby population centers (e.g., California's Central Valley and San Francisco Bay) appears to be increasing. It is anticipated that the number of people using the Stillwater NWR Complex for hunting, wildlife observation, and environmental education will continue to increase as nearby cities grow and wetland-habitat acreage becomes more reliable from year to year.

Management Implications:

Managers must recognize increasing populations and subsequent rises in demands for wildlife-dependent recreational opportunities, which could result in the establishment of wildlife-viewing trails, blinds for wildlife photography and wildlife viewing, and wildlife observation towers, all geared toward enhancing opportunities for the general public. Design and placement of these facilities should be done in a way that minimizes the adverse impacts that can result from an unstructured approach to providing such opportunities.

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APPENDIX O:
Compatibility Determinations

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DRAFT COMPATIBILITY DETERMINATIONS
for Uses Identified under Alternative C
STILLWATER NATIONAL WILDLIFE REFUGE COMPLEX

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Stillwater National Wildlife Refuge Compatibility Determinations
— An Introduction and Overview —

The draft compatibility determinations included in this appendix are the first ones that have been done for the Stillwater National Wildlife Refuge (NWR) Complex. Compatibility determinations have not been done for activities occurring on the Stillwater NWR Complex until now because the previous management authority for Stillwater NWR and Stillwater WMA were different than they are now. To the extent that a boundary revision would encompass lands that are now within Stillwater WMA, Fallon NWR, and adjacent lands, this compatibility determination will cover all Federal lands within the new approved boundary of Stillwater NWR. Until the boundary is revised, this compatibility determination covers only those Federal lands that currently exist within Stillwater NWR and Fallon NWR.

As the compatibility determinations are revised and updated, the corresponding detailed discussions of anticipated impacts should also be updated with new information. Because changes will be made over time, new additions will have to be dated.

The purpose of the "Anticipated Impacts" sections are to critically and objectively evaluate the potential effects that the given use could have on the wildlife, habitat, and public-use elements within the scope of refuge purposes, through the use of professional judgement and available information. The purpose of the Anticipated Impacts section is not to show how the hunt program is compatible, as provisions to ensure compatibility are addressed in another section. Nor do compatibility determinations address the many, critical contributions that user groups have made to the conservation of wildlife and their habitat. Compatibility determinations are used to assess the effects that people have on birds and other wildlife when people are walking, boating, driving, and otherwise enjoying their chosen activity in wildlife habitat. By its very nature, the presence of people and human activities have few if any positive effects on wildlife while the activity is occurring. Despite the focus of these compatibility determinations on human disturbance, it is well recognized that engaging in wildlife-dependent recreation has given many people a deeper appreciation of wildlife and a better understanding of the importance of conserving their habitat, which has ultimately contributed to the Refuge System mission. Furthermore, a major goal of Stillwater NWR is to provide opportunities for wildlife-dependent recreation. Of key importance, then, is to design a public-use program in such a way that adverse impacts are maintained within acceptable limits so that the many benefits that refuges can potentially provide to wildlife are not diminished. To do this effectively, we must understand and recognize the adverse impacts.

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COMPATIBILITY DETERMINATION
— DRAFT —
(March 2000)

Use: Hunting (Option 1 of Alternative C[1])

Refuge Name: Stillwater National Wildlife Refuge[2]

Establishing and Acquisition Authority(ies):

The Truckee-Carson-Pyramid Lake Water Rights Settlement Act of 1990 (Title II of Public Law 101-618) — Stillwater NWR.

Refuge Purpose(s):

Subsection 206(b)(2) of Public Law 101-618 expanded Stillwater NWR to its present approved boundary, and directed that the refuge "shall be managed by the Secretary through the United States Fish and Wildlife Service for the purposes of:

- (A) maintaining and restoring natural biological diversity within the refuge;
- (B) providing for the conservation and management of fish and wildlife and their habitats within the refuge;
- (C) fulfilling the international treaty obligations of the United States with respect to fish and wildlife; and
- (D) providing opportunities for scientific research, environmental education, and fish and wildlife oriented recreation."

The Refuge System Mission is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

Description of Use:

Continuation of hunting on Stillwater NWR is being evaluated because it is a priority public use of the Refuge System and a "wildlife-oriented recreational use" (a refuge purpose), and because it is a traditional use of the Stillwater Marsh. Its continuation is advocated by several hunting groups and individuals and the Nevada Division of Wildlife, among other groups. This wildlife-dependent recreational use is supported by several other activities, including boating and overnight stays. Because they are highly interrelated, this compatibility determination includes an assessment of these other activities in conjunction with hunting. Several environmental groups have supported the continuation of hunting on Stillwater NWR.

Opportunities for waterfowl hunting on Stillwater NWR will be available during the waterfowl hunting season in compliance with annually-published waterfowl hunting regulations. Waterfowl hunting season generally falls within the period October-January. Waterfowl hunting will be permitted every day in the area delineated as the "hunt area" on Map 3.3 (page 144 of the Internal Draft of the Stillwater NWR Complex Environmental Impact Statement for the Comprehensive Conservation Plan and Boundary Revision, Volume I), which includes all wetland units north of Division Road, except West Marsh and Lead Lake, and includes wetlands along the D-Line Canal between Lead Lake and the Indian Lakes area. All wetland units open to hunting will be maintained as free-roam and no permanent blinds will be in place.

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[1] This is the first compatibility determination completed for hunting on the Stillwater NWR Complex. No compatibility determinations have been previously prepared on waterfowl hunting on the area because the previous management authority for Stillwater NWR was different, directing that hunting be managed as a co-equal purpose with wildlife management.

[2] To the extent that a boundary revision encompasses lands that are now within Fallon NWR, Stillwater Wildlife Management area and adjacent lands, this compatibility determination would cover all Federal lands within the new boundary of Stillwater NWR under Alternative C. Until the boundary is revised, this compatibility determination covers only those Federal lands that currently exist within Stillwater NWR and Fallon NWR.

Roads will continue to encircle many wetland units in the open area or large portions of them, but many roads will continue to not be immediately adjacent to the units and a few road closures will continue to be in effect. However, access to wetland-habitat in all units open to hunting, except Goose Lake, will continue to be facilitated by boats and one to two boat landings will be provided in each unit. A variety of watercraft will be permitted, but motors will not be permitted to exceed 15 horsepower and boats would not be allowed to exceed 5 miles per hour in an effort to minimize impacts to wildlife associated with noise and speed while still providing this type of access to the marsh.

The 200-yard wide retrieval-only zone will be maintained along Division Road between the hunt area and the non-hunted public use area. Retrievers will be permitted and encouraged in all areas open to waterfowl hunting.

Wetland-habitat available during the hunting season will be affected by water management strategies, particularly the seasonal inflow pattern (Section 3.4.C.4.1.1.1 of the Draft EIS) and the apportionment of water among public-use zones during the hunting season (Section 3.4.C.5.1.3.1.1 of the Draft EIS). Up to about 45 percent of the fall/winter wetland-habitat on Stillwater NWR will be open to hunting (up to about 7,000 acres) during spill years and some years following spill years. In nonspill-years at the completion of the water-rights acquisition program, up to an estimated 45 percent of the wetland-habitat will be open to hunting (up to an estimated 4,500-5,000 acres). The remainder of wetland-habitat will be in sanctuary and non-hunted public use areas.

Under the existing program, waterfowl hunter densities in Stillwater Marsh on the first two days of the season (opening weekend) in 1998-99 was about 1 hunter per 50 acres and 84 acres of available wetland-habitat, respectively. On other weekends throughout the season, hunter densities averaged about 1 hunter per 120-190 acres of available wetland-habitat. During weekdays, the density was about 1 hunter per 315-380 acres of available wetland-habitat. Under Option 1 of Alternative C, hunter densities are anticipated to be substantially higher than this at times, as well as lower than this at other times.

Under Alternative C, hunting opportunities for California quail would be provided in the hunt area of Stillwater Marsh and along the D-Line Canal between Lead Lake and the Indian Lakes area, south of Indian Lakes Road to the southern boundary of the refuge. The Carson River corridor between Wolfe Dam and Timber Lake (but not including the Timber Lake area) would be evaluated for hunting opportunities if this land is acquired by the Service. As with waterfowl hunting, quail hunting would be carried out in compliance with annually-published State hunting regulations. Only non-toxic shot would be allowed to harvest California quail on Stillwater NWR.

Because any hunt program, if not carefully monitored and regulated, has the potential to become incompatible with refuge purposes, additional details on the hunt program are provided in the "Stipulations to Ensure Compatibility" section.

Overnight stays associated with waterfowl hunting will continue to be permitted in designated areas only. No camping facilities will be provided at these sites, except an outhouse.

Wetland-habitat within the hunt area, general public-use area, and sanctuary include shoreline meadow, moist-soil habitat (such as flooded bassia and other annual forbs and grasses, flooded saltcedar, shallow-emergent marsh, deep-emergent marsh, submergent marsh, and open water. The hunt area also encompasses riparian woodland and salt desert shrub habitats. Species of waterfowl that are anticipated to use Stillwater NWR during the hunting season are listed at the end of this compatibility determination. Other waterbirds that occur in wetland-habitat during the period October-January include American coots, shorebirds, and waders, but use by most of these birds is limited at this time of year. Coots are fairly common, at least at the beginning of

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the hunting season. Raptors during this season include bald eagles and northern harriers, and passerines include song sparrows and red-headed blackbirds. Riparian birds occurring during the hunting season include red-tailed hawks, bald eagles (roosting), great horned owls, and a variety of woodpeckers and passerine birds. Additional details are provided in Chapter 4 of the Draft EIS. Overnight stays associated with the hunt program will occur in designated sites, and therefore will not impact upland habitats.

Summary of Anticipated Impacts of the Use:

The potential impacts of Option 1 of Alternative C's hunt program on the Service's ability to achieve refuge purposes and the Refuge System mission are evaluated in detail in a table included at the end of Appendix Q of the Draft EIS (Volume II) and summarized on the following pages. The following discussion provides an executive summary of the impacts of the hunt program on the ability of the Service to achieve refuge purposes and the Refuge System mission. It is divided into major components of refuge purposes and the mission of the Refuge System. Refuge purpose components deal with habitat and wildlife while they are on the refuge, and Refuge System components deal with wildlife in a larger context (e.g., Flyway populations).

Anticipated impacts described in this section were identified and evaluated based on professional judgement and results of administrative studies and published scientific information. The table at the end of Appendix O (Attachment 1) and the literature review on the effects of human disturbance on wildlife (A. DeLong and J. Schmidt 2000; Appendix L of the Draft EIS) should be consulted for more detailed information. The results of an analysis of 30 years of Lahontan Valley waterfowl data collected by the Nevada Division of Wildlife (Bundy 2000; Appendix E) was also used. These pieces of information formed the basis of Attachment 1, which provides a more thorough assessment of the potential effects of Alternative C's hunt program.

The purpose of this section is to critically and objectively evaluate the potential effects that the hunt program could have on the wildlife, habitat, and public-use elements encompassed in refuge purposes, through the use of professional judgement and available information. The purpose of this section is not to show how the hunt program is compatible, as provisions to ensure compatibility are addressed elsewhere. Nor does this compatibility determination address the many contributions that hunters have made to the conservation of waterfowl and other wildlife and their habitat. This compatibility determination assess the effects that hunters have on birds and other wildlife when they are walking, boating, and actively hunting in wildlife habitat. By its very nature, this activity has very few if any positive effects on waterfowl and other birds while the activity is occurring (which is true of the other public-use activities on Stillwater NWR as well), but it is well recognized that this activity has given many people a deeper appreciation of wildlife and a better understanding of the importance of conserving their habitat, which has ultimately contributed to the Refuge System mission. Furthermore, despite the potential impacts of hunting, a major goal of Stillwater NWR is to provide opportunities for wildlife-dependent recreation. Of key concern, then, is to maintain adverse impacts within acceptable limits. One of the functions of this section is to point out whether adverse impacts are within or exceed these acceptable thresholds.

Effects on the Service's Ability to Achieve Purposes A-C: As demonstrated in many studies cited in Appendix L (and as analyzed specific to Alternative C's hunting program in Attachment 1), the aspect of hunting at Stillwater NWR that may have the greatest potential to adversely affect wildlife is boating, especially given the relatively large size of wetland units, limited road access in some areas, and relatively low hunter densities in years of high wetland-habitat acreage. Boating during the fall and winter has been shown to alter distribution, reduce use of particular habitats or entire areas by waterfowl and other birds, alter feeding behavior and nutritional status, and to cause premature departure from areas. Impacts of boating can occur even at low densities, given the ability to cover extensive areas in a short amount of time and the noise the produce and their speed. Other factors influencing the above listed factors include road access, hunter densities and distribution, and amount of high quality sanctuary. Although no studies have been conducted locally to ascertain these effects, analysis of 30 years of waterfowl and wetland-habitat acreage surveys in the Lahontan Valley (Bundy 2000) generally supports findings in the scientific literature summarized in DeLong and Schmidt (2000).

It is anticipated that the sanctuary, boating restrictions, and limited road closures of Option 1 of Alternative C are adequate to ensure that a sufficient amount of high-quality, preferred habitat is available for waterfowl and other birds at all times, even when hunter density is high in the hunt area.

By providing the defined amount of wetland-habitat in the original sanctuary, additional sanctuary units (West Marsh and Lead Lake) and by shallowly-flooding wetland-habitat in East and West Pasture units (which has the potential to provide annual seeds), it is anticipated that the sanctuary will provide a full range of high quality feeding, resting, and thermal habitat sufficient in quantity to allow the Service to achieve refuge purposes. Most of the higher quality habitat in the original sanctuary --- e.g., those traditionally producing excellent stands of sago pondweed and other seed-producing aquatic vegetation --- are not included in Option 1 of Alternative C's sanctuary. The addition of West Marsh should alleviate this effect to some degree. Furthermore, access to Lower Foxtail lake and other units would be limited to the road, and therefore, would continue to provide a feeding area for ducks.

However, there are several potential limitations to providing high quality habitat for feeding and thermal protection in the sanctuary under Option 1 of Alternative C. A primary consideration is that Stillwater Point Reservoir, comprising one-third or more of the sanctuary, is the refuge's main regulating reservoir, which has the potential to impair it's ability to provide suitable quality wetland-habitat in the sanctuary. This concern is supported by the finding that only 11-17 percent of ducks using the sanctuary over the last 30 years have been observed on Stillwater Point Reservoir, compared to the reservoir's acreage base of 33-45 percent of the available wetland habitat in the sanctuary (Bundy 2000). Stillwater Point Reservoir is important as a staging area for Canada geese, using nearby agricultural areas. The effectiveness of Lead Lake as sanctuary is limited because it provides little in the way of feeding habitat (it is primarily a loafing area). If West Canal is not extended to West Marsh as proposed, this will significantly impair the Service's ability to provide high quality wetland-habitat within an important part of the sanctuary under this option. Due to these potential constraints, careful monitoring and adaptive management will be imperative.

The effects of hunting on populations of California quail would include short-term changes in habitat use and possible short-term reductions in local populations. However, given the low numbers of hunters anticipated to use the area and enforcement of State Hunting Regulations, these effects would be within acceptable limits. Adverse impacts to other, nontarget species would also occur, primarily as a consequence of extensive hiking associated with hunting of the target species, but the effects are anticipated to be small given the scattered coveys of quail and concurrent low density of hunters. Because hunting would not be permitted in the vicinity of bald eagle roost sites, potential adverse impacts to bald eagles would be avoided.

Alterations to vegetative diversity in Stillwater Marsh are anticipated to be negligible, except possibly for adjustments in water management to accommodate the hunt program, including adjustments to ensure its compatibility (e.g., flooding of East and West Pastures). Although camping has been shown to adversely impact vegetation and wildlife habitat in other areas, few adverse impacts would be anticipated under Option 1 of Alternative C because overnight stays will be restricted to a small number of designated sites all of which will have discernable boundaries, likely in already disturbed areas, and will not be located in sensitive areas. Vegetation impacts resulting from upland gamebird and mammal hunting would be light considering that foot travel would not be concentrated and would occur after the growing season.

Effects on the Service's Ability to Achieve Purpose D: The hunt program under Option 1 of Alternative C will be favorable to providing opportunities for wildlife-dependent recreation from the standpoint of hunting, which is one the wildlife-dependent recreational uses of the Refuge System. Hunting opportunities would continue to abound on the refuge when there is adequate water.

The public-use program under this option will also provide opportunities for environmental education and wildlife observation during the hunting season. The hunt area will encompass approximately 60-70 percent of the wetland-habitat viewable by the public during the hunting season in most years, allowing a considerable amount of wetland-habitat to be viewed by the public outside of the hunt area. The non-hunt public-use area will include a small area dedicated to environmental education near Cattail Lake and, eventually, wetlands associated with an Administrative/Visitor facility. The peak season of non-hunting visitation is during the spring and summer, outside of the hunting season. Continued monitoring will be necessary.

Hunting has other effects on the public-use program. As noted in the Appendix L, the response of waterfowl to people is intimately related to the experience of waterfowl with hunters and hunting. An example was given of waterfowl in city parks that feed from human hands, while waterfowl that experience hunting activities flush at a distance of hundreds of yards. Thus, hunting affects experiences of refuge visitors engaging in other priority public uses of Stillwater NWR such as wildlife viewing, wildlife photography, and environmental education during the fall and winter seasons and possibly beyond. This is of consideration because most of the wetland-habitat viewable by the public during October through early to mid January are within the hunt area and effects on waterfowl in the hunt are will influence waterfowl behavior while they are in the non-hunt zone of the refuge. Non-hunted wetland units viewable by the public under Option 1 of Alternative C include Foxtail Lakes, Doghead Lake, Division Pond, Cattail Lake, West Pasture (to be constructed), small wetlands adjacent to the visitor center (to be constructed), and a small portion of Stillwater Point Reservoir. Although waterfowl and other waterbirds will be influenced by hunting in the hunt area, it is anticipated that they will habituate, at least to some extent, to visitor use in the non-hunt portion of the public-use area. Therefore, it is anticipated that the hunt program as prescribed under Option 1 of Alternative C will not diminish the Service's ability to achieve this purpose of the refuge.

Hunting also can affect viewing opportunities of California quail. Populations that are not hunted are much more readily observable by people, year-round. However, because some of the riparian habitat and farmland areas on the refuge will remain closed to hunting under this alternative, opportunities to view these species at closer ranges will be possible.

Effects on the Service's Ability to Contribute toward the Refuge System Mission: Because each refuge contributes to the conservation of fish, wildlife, plants, and their habitat in the Refuge System, the effects described previously effect the overall ability of the Service to achieve this fundamental mission. Providing high-quality habitat, which includes protection from disturbance, on Stillwater NWR is especially important given the significantly reduced acreage of wetland-habitat in Nevada (an estimated 80% reduction) where wetland-habitat is widely scattered.

From the standpoint of hunting on individual refuges, Flyway populations will most directly be effected by the mortality of birds resulting from hunting. However, because Pacific Flyway harvest regulations, developed annually, are designed to ensure that viable populations of waterfowl are sustained over the long term, the hunt program under Option 1 of Alternative C will not have any measurable impacts on the Service's ability to sustain viable populations of waterfowl species so long as regulations are enforced on the refuge. It is anticipated that hunting on Stillwater NWR will not have any measurable effects on production in northern areas.

Public Involvement:

Hunting is one of the issues being addressed in the comprehensive conservation planning process. Three public scoping meetings were conducted during March 1997 by the Department of the Interior for several potential Federal actions, including comprehensive planning at the Stillwater NWR Complex. They were conducted in Fallon, Fernley, and Reno. Six open-house workshops were conducted specifically for Stillwater NWR Complex comprehensive planning. One meeting was held in Fallon and one in Reno during each of the months March, April, and July 1997. The Service met periodically with the Nevada Division of Wildlife to discuss potential options for managing hunting on Stillwater NWR. The Service met with other groups advocating continued hunting opportunities such as the Nevada Waterfowl Association, Canvasback Gun Club, and Ducks Unlimited, and attended a meeting of the Lahontan Wetland Coalition specifically set up to discuss public-use management on Stillwater NWR. The Service also met with representatives of Churchill County, the City of Fallon. Private landowners in the study area and the Truckee-Carson Irrigation District were also encouraged to provide input into the planning process.

Additional public involvement will occur before compatibility determination is finalized.

Availability of Resources:

Costs to administer the hunt program will mostly be salaries. It is estimated that the following level of involvement by refuge staff will be required to adequately manage and monitor the hunt program over the long term:

Position and GS/WG Level	Involvement	FTE	Cost
Project Leader/Deputy Project Leader (GS-12/13)	Oversight, coordination with NDOW	0.02	$1,129
Wildlife Biologist (GS-09/11)	Monitoring, reporting, hunt plan development/updates, oversight of research and biological technicians	0.25	$13,670
Outdoor Recreation Planner (GS-07/09)	Monitoring, reporting, hunt plan development/updates, oversight of outdoor recreation technicians	0.2	$10,937
Law Enforcement Officer (GS-09/ WG-09)	Law enforcement	0.5	$22,410
Maintenance Crew (WG-09/11)	Road maintenance during winter, maintenance of boat ramps and sites for overnight stays	1.0	$44,820
Biological Technicians (GS-05)	field data collection, assistance with analysis and report writing	0.5	$11,689
Total FTEs and Costs:		2.47	$104,855

Additional funds will be required to fund a study to determine whether the sanctuary, walk-in-only area, and boating regulations, in combination, are adequate to provide a sufficient amount of relatively-undisturbed habitat for feeding, loafing, and getting away from the elements.

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Additional facilities that will be provided to support this activity include designated parking areas (value based on required maintenance), permanent blinds for disabled hunters, information kiosks (2 x $18,000), and designated areas for overnight stays including outhouses (6 x $9,000) for a total of $194,855 during the initial year, and $104,855 required in successive years to fund the hunt program of Option 2 of Alternative C. Existing boat landings and associated parking lots will be maintained and repaired as necessary.

Stipulations Necessary to Ensure Compatibility:

Published literature on the effects of hunting, boating, and camping was reviewed (Appendix L of the Draft EIS). The stipulations, which are primarily aimed at minimizing the adverse effects of boating, were based in part on this review. Also of importance was the analysis of waterfowl surveys dating back to 1970.

Of the uses occurring on Stillwater NWR, boating appears to have the greatest potential for adversely impacting wildlife in the wetlands (Attachment 1 of this appendix, Appendix L). Three factors that exert the most disturbance to wildlife due to boating are noise, speed, and significantly-increased access to more parts of the marsh (i.e., 1 boat can disturb more birds than a much higher density of walk-in hunters). Thus, boating regulations to ensure compatibility during the hunting season will include the following: (1) horsepower of boat motors cannot exceed 15 horsepower and boating speeds must be maintained below 5 mph in an effort to minimize adverse effects associated with noise and speed, and (2) boats will not be permitted in Goose Lake or any of the units in the sanctuary and general public use (nonhunt wetland units). Periodic law enforcement will ensure compliance with regulations and area closures. Assessments would be made to determine if the 15 hp and 5 mph limit are sufficient to minimize noise.

On wetlands where boating occurs during the hunting season, sanctuaries are especially important (Attachment 1 of this appendix; Appendix L). To maintain compatibility, a minimum of 4,000 acres of the refuge's wetland-habitat will be maintained as a sanctuary and, when at least 10,000 acres of wetland-habitat are available in Stillwater Marsh, a minimum 6,000 acres of wetland-habitat will be non-hunted, including the non-hunted portion of the public-use area. The water apportionment and boating regulations described under Option 1 of Alternative C must be followed to maintain compatibility. Careful monitoring will be necessary.

The following units will be maintained as sanctuaries: Stillwater Point Reservoir (except immediately adjacent to the wildlife viewing site), Upper Foxtail Lake, the southern end of Foxtail Lake, and East Pasture units. Other non-hunted units will include Doghead Lake, Dry Lake, Cattail Pond, Division Pond, East Alkali Lake, West Pasture, and Battleground Marsh. Shallow-flooded areas of annual seed-producing plants will have to be provided in the sanctuary. However, because providing this type of habitat generally detracts from the Service's ability to sustain natural habitat conditions, care must be taken to minimize this impact. Because Stillwater Point Reservoir is such a large component of the Sanctuary (30-40 percent), it must provide high quality habitat for waterfowl and other waterbirds for its acreage to be counted as sanctuary. Of concern is its primary use as the refuge's main regulating reservoir, which has the potential to impair it's ability to provide a suitable quality of sanctuary habitat. If habitat quality is below an acceptable threshold as feeding and resting habitat, sanctuary habitat will have to be provided in other units to make up the difference.

Another stipulation to maintain compatibility is that the sanctuary, including the additional sanctuary units added under this option, must provide high-quality habitat for feeding, resting, and thermal protection. Monitoring must demonstrate that sanctuary units receive significant daytime use by waterfowl throughout the hunting season, when these units contain wetland-habitat according to the water apportionment under this option.

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In the future, it may be necessary to provide a larger area outside of the hunt area that contains wetland-habitat in Stillwater Marsh for environmental education, wildlife observation, and general visitation. This will depend on changes in demand and also changes in attitudes of the interested public (at present, many people that have voiced an opinion on the subject support the mixing of uses during the hunting season).

Compatibility and safety of the upland gamebird hunt program relies on State regulations being enforced, use of non-toxic shot only, and providing areas where California quail are not hunted. The latter is in part to maintain compatibility with the public-use purpose of the refuge (i.e., viewing opportunities).

Determination:

This use has been found compatible*/not compatible (underline one).

* This use has been found compatible assuming adherence to the stipulations identified above. All circumstances cannot possibly be anticipated, and therefore, discretion must be left up to the refuge manager to manage the hunt program within the framework of Alternative C of the Draft EIS.

Justification:

This program as described was determined to be compatible, in view of the potential impacts that hunting and supporting activities (boating, overnight stays) can have on the Service's ability to achieve refuge purposes, because sufficient restrictions have been placed on boating, overnight stays, and hunting to ensure that: (1) an adequate amount of high-quality feeding and resting habitat would be available in relatively-undisturbed areas on any given day for the majority of waterfowl and other wetland birds using Stillwater NWR, and (2) limited opportunities would be provided for other wildlife-dependent recreation and environmental education during October-December. Although boating and overnight stays are not forms of wildlife-dependent recreation, they do in this case support a wildlife-dependent use. Although boating has the greatest potential to impact wetland wildlife of those activities related to hunting, implementing the prescribed control measures listed in the Stipulations section should alleviate many of these impacts.

It is anticipated that an adequate amount of wetland-habitat would be available to the majority of waterfowl and other wetland birds because (1) a core sanctuary area encompassing a full range of high-quality habitat would be maintained; (2) boating regulations would be maintained; and (3) it is assumed that hunter densities would remain relatively low in the hunt area. Thus, it is anticipated that birds will find sufficient food resources and resting places such that: their abundance and use of the refuge will not be measurably lessened, hunting pressure will not cause premature departure from the area, the physiological condition and production of waterfowl and other waterbirds will not be impaired, their behavior and normal activity patterns will not be altered dramatically, and their overall welfare will not be impaired. A program will be implemented to monitor these factors.

The public use program under Option 1 of Alternative C would provide many opportunities for other uses outside of the hunt area during October-December.

Providing hunting opportunities for California quail is justified, despite the limited number of opportunities and potential impacts of allowing the use, because this would broaden the wildlife-dependent recreational experiences at Stillwater NWR, and additional areas would be maintained in a nonhunted status.

COMPATIBILITY DETERMINATION

Determination and Concurrence Signature Page

Refuge Determination

Prepared by: ______________________________ ____________
(Signature and Title) (Date)

Refuge Manager Approval: ______________________________ ____________
(Signature and Title) (Date)

Regional Office/California-Nevada Operations Office Concurrence

Refuge Supervisor: ______________________________ ____________
(Signature and Title) (Date)

Refuges & Wildlife PARD: ______________________________ ____________
(Signature and Title) (Date)

Geographic ARD/ CNO Manager: ______________________________ ____________
(Signature and Title) (Date)

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References Cited

Bundy, R. M. 2000. An analysis of Stillwater NWR waterfowl use data:1970-present. Appendix E *of the* Stillwater National Wildlife Refuge Complex draft environmental impact statement for the comprehensive conservation plan and boundary revision. U.S. Dept. of the Inter., Fish and Wildl. Serv., Region 1, Portland, OR. 57pp.

DeLong, A. K. and J. Schmidt. 2000. Literature review: effects of human disturbance on wildlife with emphasis on wildlife-dependent recreation relevant to Stillwater NWR. Appendix L *of the* Stillwater National Wildlife Refuge Complex draft environmental impact statement for the comprehensive conservation plan and boundary revision. U.S. Dept. of the Inter., Fish and Wildl. Serv., Region 1, Portland, OR. 57pp.

List of Hunted Species of Waterfowl on Stillwater NWR

Tundra swan
Greater white-fronted goose
Brant
Canada goose
Snow goose
Ross' goose
Wood duck
Northen pintail
American wigeon
Eurasian wigeon
Northern shoveler
Green-winged teal
Cinnamon teal
Mallard
Gadwall
Lesser scaup
Greater scaup
Redhead
Canvasback
Ring-necked duck
Bufflehead
Common goldeneye
Barrow's goldeneye
Ruddy duck
American coot

COMPATIBILITY DETERMINATION
—DRAFT —
(March 2000)

Use: Hunting (Option 2 of Alternative C[1])

Refuge Name: Stillwater National Wildlife Refuge[2]

Establishing and Acquisition Authority(ies):

The Truckee-Carson-Pyramid Lake Water Rights Settlement Act of 1990 (Title II of Public Law 101-618) — Stillwater NWR.

Refuge Purpose(s):

Subsection 206(b)(2) of Public Law 101-618 expanded Stillwater NWR to its present approved boundary, and directed that the refuge "shall be managed by the Secretary through the United States Fish and Wildlife Service for the purposes of:

(A) maintaining and restoring natural biological diversity within the refuge;
(B) providing for the conservation and management of fish and wildlife and their habitats within the refuge;
(C) fulfilling the international treaty obligations of the United States with respect to fish and wildlife; and
(D) providing opportunities for scientific research, environmental education, and fish and wildlife oriented recreation."

The Refuge System Mission is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

Description of Use:

Continuation of hunting on Stillwater NWR is being evaluated because it is a priority public use of the Refuge System and a "wildlife-oriented recreational use" (a refuge purpose), and because it is a traditional use of the Stillwater Marsh. Its continuation is advocated by several hunting groups and individuals and the Nevada Division of Wildlife, among other groups. This wildlife-dependent recreational use is supported by several other activities, including boating and overnight stays. Because they are highly interrelated, this compatibility determination includes an assessment of these other activities in conjunction with hunting. Several environmental groups have supported the continuation of hunting on Stillwater NWR.

Opportunities for waterfowl hunting on Stillwater NWR will be available during the waterfowl hunting season in compliance with annually-published waterfowl hunting regulations. Waterfowl hunting season generally falls within the period October-January. Waterfowl hunting will be permitted every day in the area delineated as the "hunt area" on Map 3.4 (page 149 of the

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[1] This is the first compatibility determination completed for hunting on the Stillwater NWR Complex. No compatibility determinations have been previously prepared on waterfowl hunting on the area because the previous management authority for Stillwater NWR was different, directing that hunting be managed as a co-equal purpose with wildlife management.

[2] To the extent that a boundary revision encompasses lands that are now within Fallon NWR, Stillwater Wildlife Management area and adjacent lands, this compatibility determination will cover all Federal lands within the new boundary of Stillwater NWR. Until the boundary is revised, this compatibility determination covers only those Federal lands that currently exist within Stillwater NWR and Fallon NWR.

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Internal Draft of the Stillwater NWR Complex Environmental Impact Statement for the Comprehensive Conservation Plan and Boundary Revision, Volume I), which includes all wetland units north of Division Road, and wetlands along the D-Line Canal between Lead Lake and the Indian Lakes area. All wetland units open to hunting will be maintained as free-roam and no permanent blinds will be in place, except in West Marsh and possibly one other unit where permanent blinds will be established for disabled hunters. West Marsh, for the purposes of this compatibility determination, refers to West Marsh, Willow Lake, and Millen Lake.

Roads will continue to encircle many wetland units in the open area or large portions of them, but many roads will continue to not be immediately adjacent to the units and a few road closures will continue to be in effect. However, access to wetland-habitat in all units open to hunting, except West Marsh and Swan Lake, will continue to be facilitated by boats, for which one to two boat landings will be provided in each unit. A variety of watercraft will be permitted, but motors will not be permitted to exceed 15 horsepower and boats would not be allowed to exceed 5 miles per hour in an effort to minimize impacts to wildlife associated with noise and speed while still providing this type of access to the marsh.

The 200-yard wide retrieval-only zone will be maintained along Division Road between the hunt area and the sanctuary. Retrievers will be permitted and encouraged in all areas open to waterfowl hunting.

West Marsh and Swan Lake will be maintained as walk-in-only areas in which only walk-in hunters will be allowed. This will add to the types of waterfowl hunting opportunities in the Lahontan Valley. Watercraft will not be permitted nor will any other floating or mechanized forms of transporting gear or people. North Road and Willow Dike will be closed and parking along Center Road would only be allowed in designated parking areas. The more restrictive access regulations will be implemented in an effort to maintain low hunting pressure in these units while still providing opportunities for hunting. It is hoped that the access restrictions will be sufficient to maintain a sufficiently low level of hunting pressure, but if hunting pressure is found to be too high, other mechanisms may be needed to maintain a sufficiently low level of pressure, including implementation of density limits, a permit system, etc.

Wetland-habitat available during the hunting season will be affected by water management strategies, particularly the seasonal inflow pattern (Section 3.4.C.4.1.1.1 of the Draft EIS) and the apportionment of water among public-use zones during the hunting season (Section 3.4.C.5.1.3.2.1 of the Draft EIS). As in the existing hunt program, up to about 70 percent of the fall/winter wetland-habitat on Stillwater NWR will be open to hunting (up to about 11,000 acres) during spill years and some years following spill years. In nonspill-years at the completion of the water-rights acquisition program, up to an estimated 60 percent of the wetland-habitat will be open to hunting (up to an estimated 6,000-7,300 acres).

Under the existing program, waterfowl hunter densities in Stillwater Marsh on the first two days of the season (opening weekend) in 1998-99 was about 1 hunter per 50 acres and 84 acres of available wetland-habitat, respectively. On other weekends throughout the season, hunter densities averaged about 1 hunter per 120-190 acres of available wetland-habitat. During weekdays, the density was about 1 hunter per 315-380 acres of available wetland-habitat. Under Option 2 of Alternative C, hunter density would be somewhat higher than this at times, as well as lower than this at other times.

Under Alternative C, hunting opportunities for California quail would be provided in the hunt area of Stillwater Marsh and along the D-Line Canal between Lead Lake and the Indian Lakes area, south of Indian Lakes Road to the southern boundary of the refuge. The Carson River corridor between Wolfe Dam and Timber Lake (but not including the Timber Lake area) would be evaluated for hunting opportunities if this land is acquired by the Service. As with waterfowl hunting, quail hunting would be carried out in compliance with annually-published State hunting regulations. Only non-toxic shot would be allowed to harvest California quail on Stillwater NWR.

Because any hunt program, if not carefully monitored and regulated, has the potential to become incompatible with refuge purposes, additional details of the hunt program are provided in the "Stipulations to Ensure Compatibility" section. Overnight stays associated with waterfowl hunting will continue to be permitted in designated areas only. No camping facilities will be provided at these sites, except a toilet facility.

Wetland-habitat within the hunt area and sanctuary include shoreline meadow, moist-soil habitat (such as flooded bassia and other annual forbs and grasses, flooded saltcedar, shallow-emergent marsh, deep-emergent marsh, submergent marsh, and open water. The hunt area also encompasses riparian woodland and salt desert shrub habitats. Species of waterfowl that are anticipated to use Stillwater NWR during the hunting season are listed at the end of this compatibility determination. Other waterbirds that occur in wetland-habitat during the period October-January include American coots, shorebirds, and waders, but use by most of these birds is limited at this time of year. Coots are fairly common, at least at the beginning of the hunting season. Raptors during this season include bald eagles and northern harriers, and passerines include song sparrows and red-headed blackbirds. Riparian birds occurring during the hunting season include red-tailed hawks, bald eagles (roosting), great horned owls, and a variety of woodpeckers and passerine birds. Additional details are provided in Chapter 4 of the Draft EIS. Overnight stays associated with the hunt program will occur in designated sites, and therefore will not impact upland habitats.

Summary of Anticipated Impacts of the Use:

The potential impacts of Option 2 of Alternative C's hunt program on the Service's ability to achieve refuge purposes and the Refuge System mission are evaluated in detail in the table included at the end of Appendix Q of the Draft EIS (Volume II) and summarized on the following pages. The following discussion provides an executive summary of the impacts of the hunt program on the ability of the Service to achieve refuge purposes and the Refuge System mission. It is divided into major components of refuge purposes and the mission of the Refuge System. Refuge purpose components deal with habitat and wildlife while they are on the refuge, and Refuge System components deal with wildlife in a larger context (e.g., Flyway populations).

Anticipated impacts described in this section were identified and evaluated based on professional judgement and results of administrative studies and published scientific information. The table at the end of Appendix O (Attachment 1) and the literature review on the effects of human disturbance on wildlife (A. DeLong and J. Schmidt 2000; Appendix L of the Draft EIS) should be consulted for more detailed information. The results of an analysis of 30 years of Lahontan Valley waterfowl data collected by the Nevada Division of Wildlife (Bundy 2000; Appendix E) was also used. These pieces of information formed the basis of Attachment 1, which provides a more thorough assessment of the potential effects of Alternative C's hunt program.

The purpose of the following discussion is to critically and objectively evaluate the potential effects that the hunt program could have on the wildlife, habitat, and public-use elements encompassed in refuge purposes, through the use of professional judgement and available information. The purpose of this section is not to show how the hunt program is compatible, as provisions to ensure compatibility are addressed elsewhere. Nor does this compatibility determination address the many contributions that hunters have made to the conservation of waterfowl and other wildlife and their habitat. This compatibility determination assess the effects that hunters have on birds and other wildlife when they are walking, boating, and actively hunting in wildlife habitat. By its very nature, this activity has very few if any positive effects on waterfowl and other birds while the activity is occurring (which is true of the other public-use activities on Stillwater NWR as well), but it is well recognized that this activity has given many people a deeper appreciation of wildlife and a better understanding of the importance of conserving their habitat, which has ultimately contributed to the Refuge System mission. Furthermore, despite the potential impacts of hunting, a major goal of Stillwater NWR is to provide opportunities for wildlife-dependent recreation. Of key concern, then, is to maintain adverse impacts within acceptable limits. One of the functions of this section is to point out whether adverse impacts are within or exceed these acceptable thresholds.

Effects on the Service's Ability to Achieve Purposes A-C: As demonstrated in many studies cited in Appendix L (and as analyzed specific to Alternative C's hunting program in Attachment 1), the aspect of hunting at Stillwater NWR that may have the greatest potential to adversely affect wildlife is boating, especially given the relatively large size of wetland units, limited road access in some areas, and relatively low hunter densities in years of high wetland-habitat acreage. Boating during the fall and winter has been shown to alter distribution, reduce use of particular habitats or entire areas by waterfowl and other birds, alter feeding behavior and nutritional status, and to cause premature departure from areas. Impacts of boating can occur even at low densities, given the ability to cover extensive areas in a short amount of time and the noise the produce and their speed. Other factors influencing the above listed factors include road access, hunter densities and distribution, and amount of high quality sanctuary. Although no studies have been conducted locally to ascertain these effects, analysis of 30 years of waterfowl and wetland-habitat acreage surveys in the Lahontan Valley (Bundy 2000) generally supports findings in the scientific literature summarized in DeLong and Schmidt (2000).

It is anticipated that the sanctuary, boating restrictions, and limited road closures (including provision of a walk-in-only hunt area) of Option 2 of Alternative C are adequate to ensure that a sufficient amount of high-quality, preferred habitat is available for waterfowl and other birds at all times, even when hunter density is high in the general hunt area. The general hunt area refers to the hunt area minus the walk-in-only hunt area.

By providing the defined amount of wetland-habitat in the walk-in-only area (West Marsh and Swan Lake) and by shallowly-flooding wetland-habitat in East and West Pasture units (which has the potential to provide annual seeds), it is anticipated that the sanctuary and walk-in-only area will provide a full range of high quality feeding, resting, and thermal habitat sufficient in quantity to allow the Service to achieve refuge purposes. It is anticipated that the sanctuary will continue to produce excellent stands of sago pondweed and other seed-producing aquatic vegetation, as it traditionally has, and the sanctuary and walk-in-only area together will additionally provide annual-seed producing habitat and suitable quality thermal cover.

However, there are several potential limitations to providing high-quality habitat for feeding and thermal protection in the sanctuary and walk-in-only area under Option 2 of Alternative C. A primary consideration is that Stillwater Point Reservoir, comprising one-third or more of the sanctuary, is the refuge's main regulating reservoir, which has the potential to impair it's ability to provide suitable quality wetland-habitat in the sanctuary. This concern is supported by the finding that only 11-17 percent of ducks using the sanctuary over the last 30 years have been observed on Stillwater Point Reservoir, compared to the reservoir's acreage base of 33-45 percent of the available wetland habitat in the sanctuary (Bundy 2000). Stillwater Point Reservoir is important as a staging area for Canada geese, using nearby agricultural areas. No restrictions on the number of hunters using the general hunt area or the walk-in-only area will be implemented as part of this option, and it is possible that hunting pressure will be higher than expected, which could limit the amount of relatively-undisturbed habitat provided in the walk-in-only area. If West Canal is not extended to West Marsh as proposed, this will significantly impair the Service's ability to provide high quality wetland-habitat within relatively-undisturbed areas during the hunting season. Due to these potential constraints, careful monitoring and adaptive management will be imperative.

The effects of hunting on populations of California quail would include short-term changes in habitat use and possible short-term reductions in local populations. However, given the low numbers of hunters anticipated to use the area and enforcement of State Hunting Regulations, these effects would be within acceptable limits. Adverse impacts to other, nontarget species would also occur, primarily as a consequence of extensive hiking associated with hunting of the target species, but the effects are anticipated to be small given the scattered coveys of quail and concurrent low density of hunters. Because hunting would not be permitted in the vicinity of bald eagle roost sites, potential adverse impacts to bald eagles would be avoided.

Alterations to vegetative diversity in Stillwater Marsh are anticipated to be negligible, except possibly for adjustments in water management to accommodate the hunt program, including adjustments to ensure its compatibility (e.g., flooding of East and West Pastures). Although camping has been shown to adversely impact vegetation and wildlife habitat in other areas, few adverse impacts would be anticipated under Option 2 of Alternative C because overnight stays will be restricted to a small number of designated sites all of which will have discernable boundaries, likely in already disturbed areas, and will not be located in sensitive areas. Vegetation impacts resulting from upland gamebird and mammal hunting would be light considering that foot travel would not be concentrated and would occur after the growing season.

Effects on the Service's Ability to Achieve Purpose D: The hunt program under Option 2 of Alternative C will be favorable to providing opportunities for wildlife-dependent recreation from the standpoint of hunting, which is one the wildlife-dependent recreational uses of the Refuge System. Hunting opportunities would continue to abound on the refuge when there is adequate water, and an additional, unique type of hunting opportunity will become available under this option — walk-in-only hunting — which will provide a broader array of hunting experiences and enhance the hunt program, further to contributing to the achievement of this refuge purpose.

The public-use program under this option will also provide opportunities for environmental education and wildlife observation during the hunting season, but only limited opportunities will be provided outside of hunted areas. The hunt area will encompass 94-97 percent of the wetland-habitat viewable by the public during the hunting season, assuming that at least 4,000 acres are open to hunting. The tour loop, which will generally be closed during the hunting season would be available for guided tours and environmental education programs. Wetland-habitat will also be provided along Hunter Road (West Pasture wetlands). This will limit the effectiveness of the environmental education program and wildlife observation during the hunting season for some people and groups of people. However, many non-hunting groups have voiced their opinion that this is not a major issue and that this situation is acceptable to them. Therefore, this is not determined to be a significant impact on the Service's ability to achieve this purpose. Furthermore, the peak season of non-hunting visitation is during the spring and summer, outside of the hunting season. Continued monitoring will be necessary. Maintaining the D-Line Canal open to hunting is not anticipated to conflict with any other priority public uses because this area is generally not used by other recreators.

Hunting has other effects on the public-use program. As noted in the Appendix L, the response of waterfowl to people is intimately related to the experience of waterfowl with hunters and hunting. An example was given of waterfowl in city parks that feed from human hands, while waterfowl that experience hunting activities flush at a distance of hundreds of yards. Thus, hunting affects experiences of refuge visitors engaging in other priority public uses of Stillwater NWR such as wildlife viewing, wildlife photography, and environmental education during the fall and winter seasons and possibly beyond. This is of consideration because waterfowl numbers are much higher during the hunting season than at any other time of year and the vast majority of wetland-habitats viewable by the public during October through early to mid January are within the hunt area. Non-hunted wetland units viewable by the public under Option 2 of Alternative C include West Pasture (to be constructed), small wetlands adjacent to the visitor center (to be constructed), a small portion of Stillwater Point Reservoir, Cattail Lake, and Division Pond. The limited amount of wetland habitat viewable by the public outside of the hunt area under this option does not appear to be of major concern to the general public, based on comments received during scoping for the Draft EIS. Therefore, it is anticipated that this factor will not diminish the Service's ability to provide suitable viewing opportunities to the public, as the entire hunt area is also open for wildlife viewing.

Hunting also can affect viewing opportunities of California quail. Populations that are not hunted are much more readily observable by people, year-round. However, because some of the riparian habitat and farmland areas on the refuge will remain closed to hunting under this alternative, opportunities to view these species at closer ranges will be possible.

Effects on the Service's Ability to Contribute toward the Refuge System Mission: Because each refuge contributes to the conservation of fish, wildlife, plants, and their habitat in the Refuge System, the effects described previously effect the overall ability of the Service to achieve this fundamental mission. Providing high-quality habitat, which includes protection from disturbance, on Stillwater NWR is especially important given the significantly reduced acreage of wetland-habitat in Nevada (an estimated 80% reduction) where wetland-habitat is widely scattered.

From the standpoint of hunting on individual refuges, Flyway populations will most directly be effected by the mortality of birds resulting from hunting. However, because Pacific Flyway harvest regulations, developed annually, are designed to ensure that viable populations of waterfowl are sustained over the long term, the hunt program under Option 2 of Alternative C will not have any measurable impacts on the Service's ability to sustain viable populations of waterfowl species so long as regulations are enforced on the refuge. It is anticipated that hunting on Stillwater NWR will not have any measurable effects on production in northern areas.

Public Involvement:

Hunting is one of the issues being addressed in the comprehensive conservation planning process. Three public scoping meetings were conducted during March 1997 by the Department of the Interior for several potential Federal actions, including comprehensive planning at the Stillwater NWR Complex. They were conducted in Fallon, Fernley, and Reno. Six open-house workshops were conducted specifically for Stillwater NWR Complex comprehensive planning. One meeting was held in Fallon and one in Reno during each of the months March, April, and July 1997. The Service met periodically with the Nevada Division of Wildlife to discuss potential options for managing hunting on Stillwater NWR. The Service met with other groups advocating continued hunting opportunities such as the Nevada Waterfowl Association, Canvasback Gun Club, and Ducks Unlimited, and attended a meeting of the Lahontan Wetland Coalition specifically set up to discuss public-use management on Stillwater NWR. The Service also met with representatives of Churchill County, the City of Fallon. Private landowners in the study area and the Truckee-Carson Irrigation District were also encouraged to provide input into the planning process.

Additional public involvement will occur before compatibility determination is finalized.

Availability of Resources:

Costs to administer the hunt program will mostly be salaries. It is estimated that the following level of involvement by refuge staff will be required to adequately manage and monitor the hunt program over the long term:

Position and GS/WG Level	Involvement	FTE	Cost
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Biological Technicians (GS-05)	field data collection, assistance with analysis and report writing	0.5	$11,689
Total FTEs and Costs:		2.47	$104,855

Additional funds will be required to fund a study to determine whether the sanctuary, walk-in-only area, and boating regulations, in combination, are adequate to provide a sufficient amount of relatively-undisturbed habitat for feeding, loafing, and getting away from the elements. Additional facilities that will be provided to support this activity include designated parking areas (value based on required maintenance), permanent blinds for disabled hunters, information kiosks (2 x $18,000), and designated areas for overnight stays including outhouses (6 x $9,000) for a total of $194,855 during the initial year, and $104,855 required in successive years to fund the hunt program of Option 2 of Alternative C. Existing boat landings and associated parking lots will be maintained and repaired as necessary.

Stipulations Necessary to Ensure Compatibility:

Published literature on the effects of hunting, boating, and camping was reviewed (A. DeLong and J. Schmidt 2000; Appendix L of the Draft EIS). The stipulations, which are primarily aimed at minimizing the adverse effects of boating, were based in part on this review. Also of importance was the analysis of waterfowl surveys dating back to 1970 (Appendix E of the Draft EIS).

Of the uses occurring on Stillwater NWR, boating appears to have the greatest potential for adversely impacting wildlife in the wetlands (Attachment 1 of this appendix, Appendix L). Three factors that exert the most disturbance to wildlife due to boating are noise, speed, and significantly-increased access to more parts of the marsh (i.e., 1 boat can disturb more birds than a much higher density of walk-in hunters). Thus, boating regulations to ensure compatibility during the hunting season will include the following: (1) horsepower of boat motors cannot exceed 15 horsepower and boating speeds must be maintained below 5 mph in an effort to minimize adverse effects associated with noise and speed, and (2) boats will not be permitted in West Marsh and Swan Lake, and boating would be restricted to nonmotorized boats in Lead Lake. Periodic law enforcement will ensure compliance with regulations and area closures. Assessments would be made to determine if the 15 hp and 5 mph limit are sufficient to minimize noise.

On wetlands where boating occurs during the hunting season, sanctuaries (or areas similarly providing relatively secure habitat) are especially important (Attachment 1 of this appendix; Appendix L). To maintain compatibility, a minimum of 4,000 acres of the refuge's wetland-habitat will be maintained as a sanctuary and, when 9,000 or more acres of wetland-habitat is available in Stillwater Marsh, a minimum 2,500 acres of wetland-habitat will be maintained in the walk-in-only hunt area. The water apportionment and boating regulations described under Option 2 of Alternative C must be followed to maintain compatibility. Because this option represents a minimum approach to maintaining an adequate amount of relatively-undisturbed habitat, careful monitoring will be necessary. This compatibility determination assumes that hunter densities in the general hunt area do not exceed 1 hunter per 100 acres on the vast majority of days.

The following units will be maintained as sanctuaries: Stillwater Point Reservoir (except immediately adjacent to the wildlife viewing site), Lower Foxtail Lake, Doghead Lake, Dry Lake, Division Road, Cattail Lake, and East Alkali Lake. No public access will be permitted in these units throughout the year. Shallow-flooded areas of annual seed-producing plants would be provided in the sanctuary. However, because providing this type of habitat generally detracts from the Service's ability to sustain natural habitat conditions, care must be taken to minimize this impact. Because Stillwater Point Reservoir is such a large component of the Sanctuary (30-45 percent), it must provide high quality habitat for waterfowl and other waterbirds for its acreage to be counted as sanctuary. Of concern is its primary use as the refuge's main regulating reservoir, which has the potential to impair it's ability to provide a suitable quality of sanctuary habitat. If habitat quality is below an acceptable threshold as feeding and resting habitat for a range of waterfowl species, sanctuary habitat will have to be provided in other units to make up the difference.

Another stipulation to maintain compatibility is that the walk-in-only area must provide high-quality habitat for feeding, resting, and thermal protection and it's vast majority must remain free from disturbance on any given day, although the actual location of relatively-undisturbed habitat may vary from day to day. Disturbance effects caused by hunting and other recreational activities in the walk-in-only area must remain within levels that allow waterfowl and other waterbirds to make daytime use of the vast majority of the area without being disturbed. Monitoring must demonstrate that West Marsh and Swan Lake receive significant daytime use by waterfowl throughout the hunting season, when these units contain wetland-habitat according to the water apportionment under this option. It is anticipated that the regulations pertaining to the walk-in-only area (no floatation devices or other mechanisms for transporting people or equipment and closure of North and Willow Dike roads) will be sufficient to maintain a sufficiently low density of hunters in the area, but if it is found that these regulations are insufficient, additional measures must be taken to ensure that the above stipulations are realized. This compatibility determination assumes that North Road and Willow Dike Road remain closed. The intent of the walk-in-only area is to supplement the relatively small sanctuary in an effort to provide waterfowl with a sufficient amount of relatively-undisturbed habitat for feeding, loafing, and thermal regulation.

In the future, it may be necessary to provide a larger area outside of the hunt area that contains wetland-habitat in Stillwater Marsh for environmental education, wildlife observation, and general visitation. This will depend on changes in demand and also changes in attitudes of the interested public (at present, many people that have voiced an opinion on the subject support the mixing of uses during the hunting season).

Compatibility and safety of the upland gamebird hunt program relies on State regulations being enforced, use of non-toxic shot only, and providing areas where California quail are not hunted. The latter is in part to maintain compatibility with the public-use purpose of the refuge (i.e., viewing opportunities).

Determination:

This use has been found compatible*/not compatible (underline one).

* This use has been found compatible assuming adherence to the stipulations identified above. All circumstances cannot possibly be anticipated, and therefore, discretion must be left up to the refuge manager to manage the hunt program within the framework of Alternative C of the Draft EIS.

Justification:

This program as described was determined to be compatible, in view of the potential impacts that hunting and supporting activities (boating, overnight stays) can have on the Service's ability to achieve refuge purposes, because sufficient restrictions have been placed on boating, overnight stays, and hunting to ensure that: (1) an adequate amount of high-quality feeding and resting habitat would be available in relatively-undisturbed areas on any given day for the majority of waterfowl and other wetland birds using Stillwater NWR, and (2) limited opportunities would be provided for other wildlife-dependent recreation and environmental education during October-December. Although boating and overnight stays are not forms of wildlife-dependent recreation, they do in this case support a wildlife-dependent use. Although boating has the greatest potential to impact wetland wildlife of those activities related to hunting, implementing the prescribed control measures listed in the Stipulations section should alleviate many of these impacts.

Despite the large area that would remain open to hunting, it is anticipated that an adequate amount of wetland-habitat would be available to the majority of waterfowl and other wetland birds because (1) a core sanctuary area encompassing a full range of high-quality habitat would be maintained; (2) additional relatively-undisturbed habitat would be provided in a walk-in-only area, in which the vast majority of the area would remain undisturbed on any given day; (3) boating regulations would be maintained; and (4) it is assumed that hunter densities would remain relatively low in the hunt area. Thus, it is anticipated that birds will find sufficient food resources and resting places such that: their abundance and use of the refuge will not be measurably lessened, hunting pressure will not cause premature departure from the area, the physiological condition and production of waterfowl and other waterbirds will not be impaired, their behavior and normal activity patterns will not be altered dramatically, and their overall welfare will not be impaired. A program will be implemented to monitor these factors.

Although the waterfowl hunt program, as designed, will continue to limit viewing opportunities for birdwatchers, general visitor, and people visiting the refuge on environmental education field trips, this is justified because at this time, this is not of major concern to the visiting public. For

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those people or school groups wishing to visit the refuge during October-December, guided tours into a closed portion of the marsh would be available.

Providing hunting opportunities for California quail is justified, despite the limited number of opportunities and potential impacts of allowing the use, because this would broaden the wildlife-dependent recreational experiences at Stillwater NWR, and additional areas would be maintained in a nonhunted status.

COMPATIBILITY DETERMINATION

Determination and Concurrence Signature Page

Refuge Determination

Prepared by: ______________________________ ____________
(Signature and Title) (Date)

Refuge Manager Approval: ______________________________ ____________
(Signature and Title) (Date)

Regional Office/California-Nevada Operations Office Concurrence

Refuge Supervisor: ______________________________ ____________
(Signature and Title) (Date)

Refuges & Wildlife PARD: ______________________________ ____________
(Signature and Title) (Date)

Geographic ARD/ CNO Manager: ______________________________ ____________
(Signature and Title) (Date)

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List of Hunted Species of Waterfowl on Stillwater NWR

Tundra swan
Greater white-fronted goose
Brant
Canada goose
Snow goose
Ross' goose
Wood duck
Northern pintail
American wigeon
Eurasian wigeon
Northern shoveler
Green-winged teal
Cinnamon teal
Mallard
Gadwall
Lesser scaup
Greater scaup
Redhead
Canvasback
Ring-necked duck
Bufflehead
Common goldeneye
Barrow's goldeneye
Ruddy duck
American coot

COMPATIBILITY DETERMINATION
--- DRAFT ---
(March 2000)

Use: Environmental Education and Interpretation (Options 1 and 2 of Alternative C[1])

Refuge Name: Stillwater National Wildlife Refuge[2]

Establishing and Acquisition Authority(ies):

The Truckee-Carson-Pyramid Lake Water Rights Settlement Act of 1990 (Title II of Public Law 101-618) — Stillwater NWR.

Refuge Purpose(s):

Subsection 206(b)(2) of Public Law 101-618 expanded Stillwater NWR to its present approved boundary, and directed that the refuge "shall be managed by the Secretary through the United States Fish and Wildlife Service for the purposes of:

(A) maintaining and restoring natural biological diversity within the refuge;
(B) providing for the conservation and management of fish and wildlife and their habitats within the refuge;
(C) fulfilling the international treaty obligations of the United States with respect to fish and wildlife; and
(D) providing opportunities for scientific research, environmental education, and fish and wildlife oriented recreation."

The Refuge System Mission is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

Description of Use:

Environmental education and interpretation are considered simultaneously in this compatibility determination because of the emphasis on educating the public. Environmental education typically denotes a guided or instructed educational opportunity, with refuge personnel leading a tour, workshop, school group, or related endeavor. Environmental interpretation provides an opportunity for a self-guided educational experience through provision of educational signs and/or interpretive kiosks located along either an auto tour loop or wildlife observation trail. The following is a brief description of both types of educational opportunities provided under Alternative C within the Stillwater NWR Comprehensive Conservation Plan (CCP). The reader is referred to the CCP for details of each program.

Environmental Education: The focus of the environmental education program will be the development of a staffed visitor center and outdoor classroom near the main entrance of the refuge located adjacent to Hunter Rd. and Stillwater Rd. Additionally, an active outdoor

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[1] This is the first compatibility determination completed for environmental education and interpretation on the Stillwater NWR Complex. No compatibility determinations have been previously prepared for environmental education and interpretation on the area because the previous management authority for Stillwater NWR was different.

[2] To the extent that a boundary revision encompasses lands that are now within Fallon NWR, Stillwater Wildlife Management area and adjacent lands, this compatibility determination will cover all Federal lands within the new boundary of Stillwater NWR. Until the boundary is revised, this compatibility determination covers only those Federal lands that currently exist within Stillwater NWR and Fallon NWR.

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education program would provide school and other interest groups an opportunity to learn about Stillwater NWR habitats, wildlife, and archaeological resources. While it is intended that these activities would be centrally located near the visitor center and outdoor classroom, the program would remain mobile throughout refuge habitats, allowing for specialized educational opportunities based on the desired experience of the individual group. An outdoor education site would be established at either the eastern end of Cattail Lake (Option 1) or the NE corner of Duff's Pond (Option 2), which would be the primary location(s) for environmental education opportunities until the visitor center and outdoor classroom are constructed. These sites would remain available for environmental education after the facility has been constructed.

Environmental Interpretation: For individuals desiring a self-guided educational experience, several sites and forms of interpretive trails will be developed. Interpretive wildlife observation trails and/or boardwalks would be established at Stillwater Point Reservoir (located at the southeast corner of Stillwater NWR), Timber Lakes, and the former Alves property (the latter two sites located along the Carson River). Along these trails, interpretive signs would be placed which explain the importance of various habitats to both the wildlife and peoples that have occurred throughout the Lahontan Valley. In addition, two interpretive auto tour loops would be developed at Battleground Point (located at the southeast end of the present Fallon NWR) and in one of two locations at the southeast corner of Stillwater NWR. Under Option 1 of the Stillwater NWR CCP, an auto tour loop would enter the current sanctuary off Hunter Rd., continue along the south shore of East Dry Lake, travel between Cattail and Doghead lakes, and exit at Division Road. The Option 2 tour loop would begin from Stillwater Rd. (near the existing maintenance shop), travel north along the east bank of Duff's Pond, turn east between Upper and Lower Foxtail Lakes, and then out to Hunter Rd. Both tour loops would contain pullouts and interpretive signs to provide an understanding of refuge wetland habitats, their importance to wildlife, and other values the wetlands provide. Along tour loops, passengers would be restricted to their vehicles except at designated pullouts and parking areas. The Alternative 2 tour loop would be closed to general public access during the waterfowl hunting season except for special events (e.g., refuge week) and authorized activities (e.g, guided tours and outdoor education). These exceptions will primarily occur during weekdays when hunting pressure is typically low. All other interpretative opportunities would be opened throughout the year.

Summary of Anticipated Impacts of the Use:

The purpose of this section is to critically and objectively evaluate the potential effects that the environmental education and interpretation program could have on the wildlife, habitat, and other public-use elements encompassed in refuge purposes, through the use of professional judgement and available information. The purpose of this section is not to show how the environmental education and interpretation program is compatible, as provisions to ensure compatibility are addressed elsewhere. Instead, potential impacts to habitat and wildlife resources are addressed. Of key concern, then, is to maintain adverse impacts within acceptable limits. Therefore, one of the functions of this section is to point out whether adverse impacts are within or exceed these acceptable thresholds. This summary is intended to examine impacts associated with existing levels of use and those which could occur through anticipated increases in refuge public use. This summary is intended to examine impacts associated with existing levels of use and those which could occur through anticipated increases in refuge public use.

Environmental Education: Direct impacts to wildlife and habitat would result from development of the visitor center, associated roads, and maintenance activities. This direct impact would occur on approximately 1 acre of land which exists in the historic Stillwater Slough floodplain. At present, this land is in cultivated agriculture and a continuing cooperative agreement allows this land to be used for alfalfa production and livestock grazing.

Impacts to wildlife species around this site would be minimal as wildlife diversity is typically low among agricultural habitats (Lokemoen and Beiser 1997). Development of the site could result in increased species richness as some species are attracted to human presence (Knight and Temple 1995). These species would likely not add to natural biological diversity as some are non-native (e.g., European house sparrow), and others such as the black-billed magpie, would be anticipated to increase beyond estimated natural population levels. Wetland restoration activities associated with development of the visitors center would greatly enhance habitat availability for most wildlife species.

Establishment of environmental education sites such as those proposed for the east end of Cattail Lake (Option 1) or the northeastern corner of Duff's Pond (Option 2) would locally increase disturbance impacts at, or immediately adjacent to these sites . The potential to locally and temporally alter habitat use by a variety of species exists; however, impacts would be considered light relative to low anticipated frequency of tours and ability to move environmental education sites to areas where impacts would not be as severe. For example, shorebird nesting colonies and/or areas with high densities of waterfowl nests could be seasonally located and avoided during planned environmental education field trips. Vegetation trampling, potentially altering structure and species composition among native vegetative communities would be an unavoidable impact associated with the environmental education program.

Cumulative impacts associated with environmental education sites include increased disturbance to waterfowl species during the waterfowl hunting season. Hunted species appear to be less tolerant of human intrusion, while groups such as ducks, geese, and swans which are actively hunted on northern reaches of the refuge, would likely be hypersensitive to environmental education groups in non-hunted portions of the refuge, during the waterfowl hunting season (Morton 1995). Overall, implementation of the outdoor education program is consistent with providing opportunities for environmental education (Goal 3 under Alternative C) and is not anticipated to result in measurable impacts to the Service's ability to achieve Goals 1 and 2.

Environmental Interpretation: Impacts associated with environmental interpretation activities can be divided into two categories, based on whether the activity occurs within or outside of a vehicle. In general, activities that occur outside of vehicles (e.g., interpretive wildlife observation trails, environmental education tours) tend to increase disturbance potential for most wildlife species (Klein 1993, Gabrielson and Smith 1995, Burger 1981). The proposed auto tour loop(s) would have the least impact relative to wildlife disturbance (Wolder 1993); however, additional impacts including increased exhaust emissions (Van der Sande et al. 1980), altering plant community composition and structure (Hosier and Eaton 1980, Liddle and Greig-Smith 1975), and distribution of exotic plant seeds (Lonsdale and Lane 1994) could occur through vehicle travel along the tour loop(s). It has been hypothesized that most exotic plant seeds arriving through this vector would not survive to maturity and that the majority of exotic seeds would remain with the vehicles.

Wildlife observation trails and/or interpretive pullouts along the tour loop have the greatest potential for disturbing wildlife species (Klein 1993). Among wetland habitats, frequent, out of vehicle approaches can reduce time spent foraging, or worst case, can cause waterbirds to avoid foraging habitats adjacent to the out of vehicle disturbance (Klein 1993). One possible reason for this result is that vehicle activity is usually brief while walking requires a longer period of time to cover the same distance (Gabrielson and Smith 1995). Similarly, walking on wildlife observation trails tends to displace birds and can cause declines in species richness and abundance (Riffell et al. 1996). Generalist species such as house finches and black-billed magpies tend to increase near trails while specialist species (e.g., pygmy nuthatch, solitary vireo) move away from trails. The zone of influence appears to be approximately 75 m for woodland areas adjacent to grasslands (similar to the riparian zones targeted for trail establishment; Miller et al. 1998).

Seasonality of visitation becomes important as impacts are often magnified during critical periods associated with wildlife species life history strategies. For example, during breeding season, color of clothing worn can attract or repel different passerine species based on whether the color matches breeding plumage of various species (Gutzwiller and Marcum 1997). For many passerine species, primary song occurrence and consistency can be impacted by a single visitor (Gutzwiller et al. 1994). This could potentially limit the number of breeding pairs of certain passerine species, thus limiting production within refuge riparian habitats (Reijnen and Foppen 1994). Similarly, nest predation tends to increase near more frequently visited areas for songbirds (Miller et al. 1998), raptors (Glinski 1976), colonial nesting species (Buckley and Buckley 1978), and waterfowl (Boyle and Samson 1985).

Impacts to vegetation include soil compaction (Liddle 1975, Hendee et al. 1990) which ultimately increases potential for erosion, reduces seedling emergence (Cole and Landres 1995), alters vegetative structure and composition, and increases sediment loading (Cole and Marion 1988). Often, only the most resistant vegetative species survive (Liddle 1975) with available light, surface soil moisture, and topographical changes relative to wildlife observation trails all contributing to changes in vegetative composition (Raasch 1996, Pomerantz et al. 1988).

These potential impacts are believed to be within acceptable thresholds and should not diminish the Service's ability to achieve Goals outlined under Alternative C in the Stillwater NWR CCP/Boundary Revision Draft EIS. Providing opportunities for outdoor education and interpretation is consistent with providing opportunities for outdoor education and wildlife oriented recreation (Goal 3 under Alternative C) while present use levels will not significantly impact our ability to restore and maintain natural biological diversity; conserve and manage fish, wildlife, and their habitats; or fulfill international treaty obligations with respect to fish and wildlife. While current use levels are acceptable, public use trends will be monitored and if increased public use is perceived to conflict with Goals 1 and 2, this compatibility determination will be revisited.

Public Involvement:

Environmental Education and Interpretation is one of the issues being addressed in the comprehensive conservation planning process. Three public scoping meetings were conducted during March 1997 by the Department of the Interior for several potential Federal actions, including comprehensive planning at the Stillwater NWR Complex. They were conducted in Fallon, Fernley, and Reno. Six open-house workshops were conducted specifically for Stillwater NWR Complex comprehensive planning. One meeting was held in Fallon and one in Reno during each of the months March, April, and July 1997. The Service met periodically with the Nevada Division of Wildlife to discuss potential options for managing public use on Stillwater NWR. The Service also met with representatives of Churchill County, the City of Fallon, and other interest groups including the Lahontan Audubon Society and Lahontan Wetlands Coalition, specifically to discuss public-use management at Stillwater NWR for the latter two groups. Private landowners in the study area and the Truckee-Carson Irrigation District were also encouraged to provide input into the planning process.

Additional public involvement will occur before compatibility determination is finalized.

Availability of Resources:

Direct costs to administer the environmental education and interpretation program are primarily in the form of staff time and acquisition of teaching aids. It is estimated that the following level of involvement by refuge staff will be required to adequately manage and monitor the environmental education and interpretation program over the long term:

Position and GS/WG Level	Involvement	FTE	Cost
Project Leader/Deputy Project Leader (GS-12/13)	Oversight, coordination with public use groups	0.04	$2,656
Outdoor Recreation Planner (GS-07/09/11)	Oversight and coordination of program.	0.5	$27,341
Park Ranger (GS-05/07)	Implements program	0.9	$21,040
Wildlife Biologist (GS 09/11)	Biological monitoring to ensure compatibility	0.1	$5,468
Law Enforcement Officer (GS-09/ WG-09)	Law enforcement	0.1	$4,482
Supervising Heavy Equipment Operator (WS-9)	Oversight, coordination of maintenance activities	0.05	$2,640
Heavy Equipment Operator (WG-8)	Road and trail maintenance, signing, building maintenance	0.4	$20,266
Administrative support Assistant (GS-07)	Provide General Administrative Support	0.02	$814
2 Volunteers	Staffing Visitors Center, public use monitoring	0.5	$5,000
Total FTEs and Costs:		2.6	$89,707

Additionally, $5,500 would be required to obtain and/or replace educational materials requiring a minimum annual operating budget of $62,856 to support the environmental education and interpretation program. A current RONS request for $4.3M includes construction and development of a visitor center, outdoor education classroom, outdoor education site, interpretive tour loop, two wildlife observation trails, and one interpretive boardwalk. If this request is approved, the following would be acquired and/or constructed:

4,000 sq ft visitors center	1
1,000 sq ft outdoor education classroom	1
700 sq ft contact station	1
Interpretive Wildlife observation Trails	4 mi
Interpretive Boardwalk	1 mi
Auto Tour Loop (1 way)	8.5 mi
Auto Tour Loop (pullouts/parking areas)	5
Observation Site	1
Restrooms	2
Interpretive Kiosks	3
Interpretive Signs	
Wildlife observation Trails	10/mi
Auto Tour Loop	5/mi

Stipulations Necessary to Ensure Compatibility:

While anticipated impacts are assumed to be light, stipulations will still be required to ensure that wildlife resources are adequately protected from the environmental education and interpretation program. To maintain compatibility under Option 2 of Alternative C, the tour loop

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will be closed to general public visitation during the waterfowl hunting season, thus ensuring that adequate sanctuary, and associated quality habitat, is provided for waterfowl species. The tour loop can be opened for special events (e.g., refuge week), guided tours, and outdoor education; but only during light use periods as indicated through public use monitoring and only through permission from the Stillwater NWR refuge manager. No exceptions will occur during the opening week of the waterfowl hunting season. The tour loop will remain open throughout the year under Option 1 of Alternative C unless sensitive wildlife populations are documented along the tour route. Visitors will be restricted to their vehicles except at designated pullouts and observation areas along the route(s). Interpretive signs, kiosks, and other facilities and objectives that extend above the surrounding vegetation in waterbird nesting areas must be located and designed in a way that does not provide perch sites for ravens.

The environmental education program will be designed such that identified sensitive populations or sites (e.g., areas with high densities of breeding waterbirds) are avoided. Refuge biological staff will document sensitive areas and public use staff will consult with biological staff prior to taking an outdoor education group into the field. If sensitive populations fall within permanently established outdoor education sites (e.g., northeast corner of Duff's Pond), then the site will be abandoned until the sensitive population has moved on. Additionally, wildlife observation trails will be designed such that impacts to breeding and winter roosting birds will be minimized.

Disturbance is one impact associated with of the environmental education and interpretation program; however, it is through interpretation and environmental education that visitors will increase their understanding of proper etiquette, and the effects of visitor impacts on habitat and wildlife resources. This information and refuge specific regulations will be available through a variety of media including visitor contacts, brochures, and kiosks. Periodic law enforcement will ensure compliance with regulations and area closures.

Determination:

This use has been found compatible*/not compatible (underline one).

* This use has been found compatible assuming adherence to the stipulations identified above. All circumstances cannot possibly be anticipated, and therefore, discretion must be left up to the refuge manager to manage the environmental education and interpretation program within the framework of Alternative C of the Draft EIS.

Justification:

As long as the stipulations to ensure compatibility are followed, the program will remain compatible until such time that biological and public use monitoring data suggest that modifications to the program are advisable. Environmental education and interpretation are two primary uses listed under the National Wildlife Refuge System Administration Act (1997) and are also a stated purpose under the Stillwater NWR establishing authority (P.L. 101-618), therefore, development of an environmental education and interpretation program contributes toward the Refuge System mission and Goal 4 of Alternative C for Stillwater NWR. Resources required to administer the program are minimal ($62,856 under baseline implementation) with additional components to be added as funding becomes available. Monitoring strategies will be developed to examine impacts discussed earlier in this compatibility determination and the refuge manager will use these data to modify the program accordingly.

Considering the minimal anticipated impacts through implementation of the environmental education and interpretation program, and the benefits we would receive through public education, participation, and involvement, the program is deemed compatible. Environmental education allows us to educate the public as to our mission, refuge purposes, and to highlight the areas which are most in line with the management philosophy proposed under the Stillwater NWR CCP. Additionally, designated tour loops would allow us to direct visitation away from sensitive habitats and to concentrate impacts in a smaller area of the refuge. This would minimize potential seasonal impacts in most refuge habitats while providing visitors with a high-quality educational experience.

COMPATIBILITY DETERMINATION

Determination and Concurrence Signature Page

Refuge Determination

Prepared by: ______________________ (Signature and Title) __________ (Date)

Refuge Manager Approval: ______________________ (Signature and Title) __________ (Date)

Regional Office/California-Nevada Operations Office Concurrence

Refuge Supervisor: ______________________ (Signature and Title) __________ (Date)

Refuges & Wildlife PARD: ______________________ (Signature and Title) __________ (Date)

Geographic ARD/ CNO Manager: ______________________ (Signature and Title) __________ (Date)

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Wolder, M. 1993. Disturbance of wintering northern pintails at Sacramento National Wildlife Refuge, California. M.S. Thesis, Humbolt State Univ., Arcata. 62pp.

COMPATIBILITY DETERMINATION
— DRAFT —
(March 2000)

Use: Wildlife Observation and Photography (Options 1 and 2 of Alternative C[1])

Refuge Name: Stillwater National Wildlife Refuge[2]

Establishing and Acquisition Authority(ies):

The Truckee-Carson-Pyramid Lake Water Rights Settlement Act of 1990 (Title II of Public Law 101-618) — Stillwater NWR.

Refuge Purpose(s):

Subsection 206(b)(2) of Public Law 101-618 expanded Stillwater NWR to its present approved boundary, and directed that the refuge "shall be managed by the Secretary through the United States Fish and Wildlife Service for the purposes of:

- (A) maintaining and restoring natural biological diversity within the refuge;
- (B) providing for the conservation and management of fish and wildlife and their habitats within the refuge;
- (C) fulfilling the international treaty obligations of the United States with respect to fish and wildlife; and
- (D) providing opportunities for scientific research, environmental education, and fish and wildlife oriented recreation."

The Refuge System Mission is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

Description of Use:

Wildlife Observation and photography are considered simultaneously in this compatibility determination because of the emphasis on non-consumptive public use. Many elements of the wildlife observation and photography program are similar to opportunities provided in the environmental education and interpretation program. The visitor center, interpretive auto tour loop, wildlife observation trails, and boardwalk would all provide opportunities for wildlife observers and photographers. Additional opportunities including a second tour loop around the northern section of the marsh, canoe trail(s) in Goose Lake (Option 1 of Alternative C), motorized boat access to Lead Lake (Option 2 of Alternative C), an observation platform at Stillwater Point Reservoir, and strategically located photo blinds would also be provided. The following discussion provides a brief description of each opportunity considered. The reader is referred to the Stillwater NWR Comprehensive Conservation Plan/Boundary Revision Draft EIS (Draft EIS) for a detailed description of each component.

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[1] This is the first compatibility determination completed for environmental education and interpretation on the Stillwater NWR Complex. No compatibility determinations have been previously prepared for environmental education and interpretation on the area because the previous management authority for Stillwater NWR was different.

[2] To the extent that a boundary revision encompasses lands that are now within Fallon NWR, Stillwater Wildlife Management area and adjacent lands, this compatibility determination will cover all Federal lands within the new boundary of Stillwater NWR. Until the boundary is revised, this compatibility determination covers only those Federal lands that currently exist within Stillwater NWR and Fallon NWR.

Visitor Center: A 4,000 sq ft visitor center will be constructed near the main entrance of the refuge located adjacent to Hunter Road and Stillwater Road The center will provide visitors with a list of opportunities available to them so they can choose the activity which best suits their preferences. Additionally, wetlands will be restored adjacent to the visitors center, along the Stillwater Slough floodplain, allowing opportunities for wildlife observation and photography upon arrival to the refuge.

Auto Tour Loops: A variety of tour loops will be offered within each option of Alternative C with opportunities ranging from self guided to interpreted. The following list provides a general description of where the tour loops exist and under which option they will be implemented. Detailed maps are provided within the Draft EIS.

1. Interpretive tour loop at southern end of refuge
   Hunter Rd east to south end of Dry Lake - northeast between Dry lake and Doghead Pond - out to Division Rd (Option 1)
   Stillwater Rd north to east side of Duff's Pond - west between Duff's Pond and Lower Foxtail Lake - out to Hunter Road (Option 2)
2. Stillwater Wetlands Tour Loop
   north on Hunter Road - west on Division Road - north on N Nutgrass Road - east on Navy Cabin Road - out on Hunter Road (Options 1 and 2)
   Extended version - east on Navy Cabin Road - North on Center Road - West along Lead Lake Bypass - south on West County Road (Option 1)
3. River corridor tour loop
   North on Indian Lakes Road to Battleground Point and return (Options 1 and 2)

Visitors will be restricted to their vehicles except for designated pullouts and parking areas along tour loops. All other refuge roads (not designated as tour loops) open to vehicle traffic would also be available for wildlife observation and photography.

Wildlife observation Trails: Three interpretive wildlife observation trails (4 under Option 1) would be provided which allow visitors the opportunity to get closer to wildlife species not as easy to observe from the auto tour loops. These trails would range from 1 - 2 miles in length and be established at the following locations:

1. Wetlands interpretive boardwalk following the western shoreline of Stillwater Point Reservoir. (Options 1 and 2)
2. Riparian corridor trail originating near Wolf Dam at the former Alves property (Options 1 and 2)
3. Riparian corridor and raptor observation trail originating at Timber Lakes (Options 1 and 2)
4. Upland to wetlands wildlife observation loop located at the southern end of West Dry Lake adjacent to the Option 1 interpretive tour loop. (Option 1)

Visitors will be restricted to designated trails and cannot deviate from the trails path. Seasonal closures relative to sensitive wildlife populations may apply.

Photography Blinds: One or two photography blinds will be located near high profile wildlife habitats to allow photographers to get close to potentially sensitive wildlife species, without causing excessive disturbance. These blinds will remain mobile and will be strategically placed depending on annual and seasonal variability of wildlife species distributions. An example would be placing a photo blind near the great blue heron rookery on the east end of Lower Foxtail Lake to allow photographers an extended observation period to obtain high quality photographs. Use of photography blinds will occur by special use permit only.

Observation Platforms: An observation platform will be constructed at Stillwater Point Reservoir (near the interpretive boardwalk) for both options while an additional platform would be constructed between Duff's Pond and Lower Foxtail Lake along the Option 2 interpretive tour loop. Platforms would rise approximately six feet above ground level providing observers an opportunity to see beyond dense shoreline vegetation.

Boat Access: Seasonally, boat access would be provided within individual units depending on which option of Alternative C is implemented. For Option 1, one or two canoe trails would be established in Goose Lake, providing visitors with the opportunity to enter the marsh and see some of the marsh interior wildlife, not observable from tour loops or wildlife observation trails. Under Option 2, Lead Lake would be opened to nonmotorized boat traffic. Seasonally or area specific closures may apply if sensitive wildlife populations are located along designated canoe trails.

Summary of Anticipated Impacts of the Use:

The purpose of this section is to critically and objectively evaluate the potential effects that the wildlife observation and photography could have on the wildlife, habitat, and other public-use elements encompassed in refuge purposes, through the use of professional judgement and available information. The purpose of this section is not to show how the wildlife observation and photography program is compatible, as provisions to ensure compatibility are addressed elsewhere. Instead, potential impacts to habitat and wildlife resources are addressed. Of key concern, then, is to maintain adverse impacts within acceptable limits. Therefore, one of the functions of this section is to point out whether adverse impacts are within or exceed these acceptable thresholds. This summary is intended to examine impacts associated with existing levels of use and those which could occur through anticipated increases in refuge public use.

Wildlife Observation Trails and Auto Tour Loops: Impacts associated with wildlife observation activities can be divided into two categories, based on whether the activity occurs within or outside of a vehicle. In general, activities that occur outside of vehicles (e.g., interpretive wildlife observation trails, environmental education tours) tend to increase disturbance potential for most wildlife species (Klein 1993, Gabrielson and Smith 1995, Burger 1981). The proposed auto tour loop(s) would have the least impact relative to wildlife disturbance (Wolder 1993); however, additional impacts including increased exhaust emissions (Van der Sande et al. 1980), altering plant community composition and structure (Hosier and Eaton 1980, Liddle and Greig-Smith 1975), and distribution of exotic plant seeds (Lonsdale and Lane 1994) could occur through vehicle travel along the tour loop(s). It has been hypothesized that most exotic plant seeds arriving through this vector would not survive to maturity and that the majority of exotic seeds would remain with the vehicles.

Wildlife observation trails and/or pullouts along the tour loop have the greatest potential for disturbing wildlife species (Klein 1993). Among wetland habitats, frequent, out of vehicle approaches can reduce time spent foraging, or worst case, can cause waterbirds to avoid foraging habitats adjacent to the out of vehicle disturbance (Klein 1993). One possible reason for this result is that vehicle activity is usually brief while walking requires a longer period of time to cover the same distance (Gabrielson and Smith 1995). Similarly, walking on wildlife observation trails tends to displace birds and can cause localized declines in species richness and abundance (Riffell et al. 1996). Generalist species such as house finches and black-billed magpies tend to increase near trails while specialist species (e.g., pygmy nuthatch, solitary vireo) move away from trails. The zone of influence appears to be approximately 75 m for woodland areas adjacent to grasslands (similar to the riparian zones targeted for trail establishment; Miller et al. 1998).

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Seasonality of visitation becomes important as impacts are often magnified during critical periods associated with wildlife species life history strategies. During breeding season, color of clothing worn can attract or repel different passerine species based on whether the color matches breeding plumage of various species (Gutzwiller and Marcum 1997). For many passerine species, primary song occurrence and consistency can be impacted by a single visitor (Gutzwiller et al. 1994). This could potentially limit the number of breeding pairs of certain passerine species, thus limiting production within refuge riparian habitats (Reijnen and Foppen 1994). Similarly, nest predation tends to increase near more frequently visited areas for songbirds (Miller et al. 1998) raptors (Glinski 1976), colonial nesting species (Buckley and Buckley 1978), and waterfowl (Boyle and Samson 1985).

Impacts to vegetation include soil compaction (Liddle 1975, Hendee et al. 1990) which ultimately increases potential for erosion, reduces seedling emergence (Cole and Landres 1995), alters vegetative structure and composition, and increases sediment loading (Cole and Marion 1988). Often, only the most resistant vegetative species survive (Liddle 1975) with available light, surface soil moisture, and topographical changes relative to wildlife observation trails all contributing to changes in vegetative composition (Raasch 1996, Pomerantz et al. 1988).

Wildlife Photography: Of the wildlife observation techniques, wildlife photographers tend to have the largest disturbance impacts (Klein 1993, Morton 1995, Dobb 1998). While wildlife observers frequently stop their vehicles to view different species and habitats, wildlife photographers are much more likely to leave their vehicles and approach wildlife on foot (Klein 1993). Even slow approach by wildlife photographers tends to have behavioral consequences to wildlife species (Klein 1993). Other impacts include the potential for some photographers to remain close to wildlife for extended periods of time, in an attempt to habituate the wildlife subject to their presence (Dobb 1998) and the tendency of casual photographers, with low power lenses, to get much closer to their subject than other activities would require (Morton 1995).

Boat/Canoe Access: Boating impacts on wildlife resources can be classified based on the form of boating activity (Korschgen and Dahlgren 1992, Kahlert 1994, Knight and Cole 1995), the season of use (Burger et al. 1995, Korschgen and Dahlgren 1992), and species tolerance to the activity (Tuite et al. 1983, Jahn and Hunt 1964). For example, motorboat activity likely has more disturbance impact on wildlife than non-motorized boat travel because motorboats produce a combination of movement and noise (Tuite et al. 1983, Knight and Cole 1995). Additionally, direction of boat travel influences disturbance response as birds tend to flush at greater distances when approached head on (Knight and Cole 1995). Even canoes and rowboats can cause significant disturbance effects based on the ability to penetrate into shallower areas of the marsh (Speight 1973). However, compared to motor and airboats,, canoe and/or rowboat travel appears to have the least disturbance effects on most wildlife species (Jahn and Hunt 1964).

Individual species life history requirements are an important consideration when attempting to understand seasonal impacts relative to disturbance (Korschgen and Dahlgren 1992). Boating activity can decrease time spent in courtship displays (Bouffard 1982), cause nest abandonment in upland nesting waterfowl (Korschgen and Dahlgren 1992), displace colonial nesting species (Rodgers and Smith 1997), submerge or tip overwater nests (Bouffard 1982, Reichholf 1976), cause species to abandon traditional molt sites (Sterling and Dzubin 1967), decrease time spent foraging during migration periods (Kahl 1991), and can displace birds from prime foraging habitats (Thornburg 1973). Boating intensity is directly related to waterbird response (Kahl 1991), with different species displaying varying tolerance levels (Tuite et al. 1983, Parr 1974, Jahn and Hunt 1964). Habituation to light boating intensities has been reported for some species ().

Season of use also effects wetland vegetation as communities are less susceptible to damage during winter dormancy (Liddle and Scorgie 1980). Desirable vegetation effects during this period include dispersal of seeds and reproductive plant structures which may increase spread and survival of desirable submergent plant communities; however, exotic plant species could be spread similarly. During the growing season, impacts are typically more severe, with shaft depth, propeller size, and speed all contributing to impacts (Crossland 1976). Similar to wildlife disturbance, intensity of use is directly related to severity of vegetation impacts (Haslam 1978).

Cumulative Impacts: Considering the variety of public use activities occurring at Stillwater NWR, seasonal analyses must be conducted to determine sensitive periods and appropriate solutions to minimize impacts. For example, during fall migration, wildlife education and interpretation, waterfowl hunting, and wildlife observation and photography are all occurring simultaneously. Considering that waterfowl species comprise the largest proportion of Stillwater NWR wildlife during this period, techniques to limit disturbance to this guild must be evaluated and implemented. While these techniques will be explained in following sections, the necessity stems from the hypothesis that "prolonged and extensive disturbance may cause large numbers of waterfowl to leave disturbed wetlands and migrate elsewhere". These migrations can be "distant and permanent in areas of sparse habitat, causing shifts in flyway migration patterns" (Korschgen and Dahlgren 1992). Current use is likely not of sufficient magnitude to initiate changes in migration corridors; however, anticipated use increases relative to expansion of refuge public use opportunities could result in geographic and/or seasonal shifts in waterfowl use of Stillwater NWR wetland habitats.

Public Involvement:

Wildlife Observation and photography is one of the issues being addressed in the comprehensive conservation planning process. Three public scoping meetings were conducted during March 1997 by the Department of the Interior for several potential Federal actions, including comprehensive planning at the Stillwater NWR Complex. They were conducted in Fallon, Fernley, and Reno. Six open-house workshops were conducted specifically for Stillwater NWR Complex comprehensive planning. One meeting was held in Fallon and one in Reno during each of the months March, April, and July 1997. The Service met periodically with the Nevada Division of Wildlife to discuss potential options for managing public use on Stillwater NWR. The Service also met with representatives of Churchill County, the City of Fallon, and other interest groups including the Lahontan Audubon Society and Lahontan Wetlands Coalition, specifically to discuss public-use management at Stillwater NWR for the latter two groups. Private landowners in the study area and the Truckee-Carson Irrigation District were also encouraged to provide input into the planning process.

Additional public involvement will occur before compatibility determination is finalized.

Availability of Resources:

Direct costs to administer the wildlife observation and photography program are primarily in the form of staff time with additional components and educational aids provided through implementation of the environmental education and interpretation program. It is estimated that the level of involvement by refuge staff shown on the following page will be required to adequately manage and monitor the wildlife observation and photography program over the long term.

Other costs associated with implementation of the wildlife observation and photography program include maintenance and fuel for heavy equipment used to maintain roads and trails. This should cost approximately $5,000 resulting in a $77,489 annual cost.

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Position and GS/WG Level	Involvement	FTE	Cost
Project Leader/Deputy Project Leader (GS-12/13)	Oversight, coordination with public use groups	0.01	$664
Outdoor Recreation Planner (GS-07/09/11)	Oversight and coordination of program.	0.4	$21,873
Park Ranger (GS-05/07)	Implements program	0.5	$11,689
Wildlife Biologist (GS 09/11)	Biological monitoring to ensure compatibility	0.1	$5,468
Law Enforcement Officer (GS-09/ WG-09)	Law enforcement	0.1	$4,482
Supervising Heavy Equipment Operator (WS-9)	Oversight, coordination of maintenance activities	0.05	$2,640
Heavy Equipment Operator (WG-8)	Road and trail maintenance, signing, building maintenance	0.4	$20,266
Administrative support Assistant (GS-07)	Provide General Administrative Support	0.01	$407
2 Volunteers	Staff visitors center, public use monitoring	0.5	$5,000
Total FTEs and Costs:		2.1	$72,489

Stipulations Necessary to Ensure Compatibility:

Considering the wide variety of opportunities associated with the wildlife observation and photography program, cumulative impacts to wildlife resources and habitat could potentially be moderate. However, stipulations to ensure compatibility for each component outlined in the description of use section, should minimize these impacts to a point where the wildlife observation and photography program would be compatible with the purposes established for Stillwater NWR. The following discussion examines each component and provides a brief discussion of program modifications necessary to ensure compatibility.

Wildlife Observation Trails and Auto Tour Loops: To maintain compatibility under Option 2 of Alternative C, the tour loop will be closed to general public visitation during the waterfowl hunting season, thus ensuring that adequate sanctuary, and associated quality habitat, is provided for waterfowl species. The tour loop can be opened for special events (e.g., refuge week), guided tours, and outdoor education; but only during light use periods as indicated through public use monitoring and only through permission from the Stillwater NWR refuge manager. No exceptions will occur during the opening week of the waterfowl hunting season. The tour loop will remain open throughout the year under Option 1 of Alternative C unless sensitive wildlife populations are documented along the tour route. Visitors will be restricted to their vehicles except at designated pullouts and observation areas along the route(s). All tour loops and hiking trails discussed in this compatibility determination will be subject to seasonal closures based on presence of sensitive wildlife species and/or habitats.

Wildlife Photography: As discussed, impacts associated with wildlife photography could potentially cause the most disturbance towards wildlife resources as photographers are most prone to exiting their vehicles and approaching wildlife on foot. To alleviate this impact, photographers will be restricted to designated pullouts and parking areas along the interpretive auto tour loop(s) and along established hiking trails. Photography in the northern reaches of the refuge (north of division road) would be open to unrestricted wildlife photography except that, wildlife photography would be subject to the same seasonal closures discussed above. One or two photography/observation blinds would be provided in potentially sensitive areas (e.g., great blue heron nesting areas) to allow photographers access to wildlife populations in a more natural setting. Photography blinds will remain mobile and will be strategically placed near quality observation sites. Photography blind use will be subject to refuge manager permission, under stipulations outlined in an individually issued, special use permit.

Boat Access: To ensure compatibility, all refuge units would be closed to all boating activity between March 1 and August 1 with the following exceptions. Under Option 1 of Alternative C, one or two canoe trails would be established in Goose Lake and under Option 2 of Alternative C, Lead lake would be open to non-motorized boat use. Boat use at Goose Lake would be restricted to designated trails. These options would be subject to seasonal closures or moved to accommodate overwater nesting bird populations as high density nesting locations are identified by refuge biological staff.

For all uses identified in this compatibility determination, monitoring protocol would be developed to examine impacts associated with differing levels and types of public use. While acceptable thresholds to continue uses will likely not become available through these efforts, data will be critically analyzed and used to provide the refuge manager with sound professional judgement relative to future modifications necessary to ensure compatibility within the wildlife observation and photography program.

Determination:

This use has been found compatible*/not compatible (underline one).

* This use has been found compatible assuming adherence to the stipulations identified above. All circumstances cannot possibly be anticipated, and therefore, discretion must be left up to the refuge manager to manage the environmental education and interpretation program within the framework of Alternative C of the Draft EIS.

Justification:

Under the stipulations identified in this compatibility determination, providing opportunities for wildlife observation and photography would contribute towards fulfilling provisions outlined under the National Wildlife Refuge Administration Act (1997) and fulfilling the Stillwater NWR establishing authority (Title II of Public Law 101-618). Wildlife observation and photography would provide an excellent forum for allowing public access to their wildlife resources; particularly when combined with a stop at the refuge visitors center and/or a tour along one of the refuges interpretive tour loops or hiking trails. The educational possibilities provided by these opportunities would outweigh anticipated light to moderate impacts associated with implementation of the program, where stipulations outlined above should minimize potential impacts relative to wildlife/human interactions.

COMPATIBILITY DETERMINATION

Determination and Concurrence Signature Page

Refuge Determination

Prepared by: ______________________________ ____________
(Signature and Title) (Date)

Refuge Manager Approval: ______________________________ ____________
(Signature and Title) (Date)

Regional Office/California-Nevada Operations Office Concurrence

Refuge Supervisor: ______________________________ ____________
(Signature and Title) (Date)

Refuges & Wildlife PARD: ______________________________ ____________
(Signature and Title) (Date)

Geographic ARD/ CNO Manager: ______________________________ ____________
(Signature and Title) (Date)

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Wolder, M. 1993. Disturbance of wintering northern pintails at Sacramento National Wildlife Refuge, California. M.S. Thesis, Humbolt State Univ., Arcata. 62pp.

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COMPATIBILITY DETERMINATION
— DRAFT —
(March 2000)

Use: Horseback Riding (Options 1 and 2 of Alternative C[1])

Refuge Name: Stillwater National Wildlife Refuge[2]

Establishing and Acquisition Authority(ies):

The Truckee-Carson-Pyramid Lake Water Rights Settlement Act of 1990 (Title II of Public Law 101-618) — Stillwater NWR.

Refuge Purpose(s):

Subsection 206(b)(2) of Public Law 101-618 expanded Stillwater NWR to its present approved boundary, and directed that the refuge "shall be managed by the Secretary through the United States Fish and Wildlife Service for the purposes of:

(A) maintaining and restoring natural biological diversity within the refuge;
(B) providing for the conservation and management of fish and wildlife and their habitats within the refuge;
(C) fulfilling the international treaty obligations of the United States with respect to fish and wildlife; and
(D) providing opportunities for scientific research, environmental education, and fish and wildlife oriented recreation."

The Refuge System Mission is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

Description of Use:

While not one of the six wildlife dependent recreational uses outlined in the National Wildlife Refuge Administration Act (1997), horseback riding is an existing use of Stillwater NWR often used for wildlife and nature observation. As proposed, horseback riding on Stillwater NWR would occur on open roads only.

Summary of Anticipated Impacts of the Use:

The purpose of this section is to critically and objectively evaluate the potential effects that horseback riding could have on the wildlife, habitat, and other public-use elements encompassed in refuge purposes, through the use of professional judgement and available information. The purpose of this section is not to show how the horseback riding program is compatible, as provisions to ensure compatibility are addressed elsewhere. Instead, potential impacts to habitat and wildlife resources will be addressed. Of key concern, then, is to maintain adverse impacts within acceptable limits. Therefore, one of the functions of this section is to point out whether adverse impacts are within or exceed these acceptable thresholds.

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[1] This is the first compatibility determination completed for horseback riding on the Stillwater NWR Complex. No compatibility determinations have been previously prepared for horseback riding on the area because the previous management authority for Stillwater NWR was different.

[2] To the extent that a boundary revision encompasses lands that are now within Fallon NWR, Stillwater Wildlife Management area and adjacent lands, this compatibility determination will cover all Federal lands within the new boundary of Stillwater NWR. Until the boundary is revised, this compatibility determination covers only those Federal lands that currently exist within Stillwater NWR and Fallon NWR.

Impacts related to horseback riding range from exotic plant seed dispersal (Beck 1993, Hammitt and Cole 1987), soil compaction and erosion (Bainbridge 1974, Hendee et al. 1990, Hammitt and Cole 1987), stream sedimentation (Seney and Wilson 1991), trail widening (Whitaker 1978), vegetation trampling (Nagy and Scotter 1974, Weaver and Dale 1978, Whitaker 1978), aesthetic concerns relative to horse manure (Lee 1975), to direct wildlife disturbance (Owen 1973). Exotic plants can be spread to new sites through forage (e.g., hay brought in to feed horses, that contains seeds of exotic plants) and manure (Beck 1993). Horse digestive systems are relatively inefficient and seeds of exotic plants are often still viable after passing through their digestive system. This could result in introduction and/or spread of exotic species on Stillwater NWR, which could lower the Service's ability to restore and maintain natural biological diversity in refuge wetland and upland habitats.

Exotic plant establishment is further facilitated by increased trail disturbance as many exotic plants gain a competitive advantage in highly disturbed sites. This soil disturbance is often created through soil compaction with as much as 1500 pounds per-square-inch exerted on the soil surface with each step (Hendee et al. 1990). Additionally, hoof action tends to dig up and puncture the soil surface (McQuaid-Cook 1978) which causes greater sediment loss than any other form of recreational trail use (Seney and Wilson 1991) and increases potential for disturbance tolerant vegetation (e.g., exotic plant) establishment. Trail widening is also a consideration as horses tend to walk on the downslope sides of trails (Whitson 1974). Anticipated results include a wider trail, a much wider area of disturbance, and ongoing trail maintenance problems.

Vegetation impacts can be much more pronounced considering that hikers tend to flatten vegetation while horses tend to churn up soil, thus, cutting plants off at the rootstalk (Whitaker 1978). This can increases spread of previously established exotics by providing loose disturbed soil for germination and spreading reproductive plant structures. This impact initially increases species richness (through exotic plant encroachment) with light to moderate trail use and eventually lowers richness values to near 0 with heavy impacts (Hendee et al. 1990).

Wildlife disturbance relative to horseback riding has been poorly studied with most references using other activities such as hiking and cross-country skiing to infer horseback riding impacts. Only one study identified disturbance tolerance of waterfowl to horseback riders and found that horseback riders could approach geese up to a distance of 46 m. This is compared to suggested hiking trail distances of 75 m (Miller et al. 1998) and boat buffers ranging from 77 to 273 m (depending on type of boat, whether motorized, and species impacted; Burger et al. 1999). The 46 m approach distance offered by Owen (1973) is consistent with observations suggesting that horseback wildlife observers can approach wildlife at closer distances than through other forms of travel. Many wildlife species appear to be habituated to livestock, thus, are less likely to flee when approached through this method. However, any form of approach will likely result in some level of disturbance-related impact.

Public Involvement:

Horseback riding is one of the issues being addressed in the comprehensive conservation planning process. Three public scoping meetings were conducted during March 1997 by the Department of the Interior for several potential Federal actions, including comprehensive planning at the Stillwater NWR Complex. They were conducted in Fallon, Fernley, and Reno. Six open-house workshops were conducted specifically for Stillwater NWR Complex comprehensive planning. One meeting was held in Fallon and one in Reno during each of the months March, April, and July 1997. The Service met periodically with the Nevada Division of Wildlife to discuss potential options for managing public use on Stillwater NWR. Private landowners in the study area and the Truckee-Carson Irrigation District were also encouraged to provide input into the planning process.

[[additional public involvement will occur before compatibility determination is finalized]]]

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Availability of Resources:

Direct costs to administer the horseback riding program would be negligible, with road maintenance and monitoring for other public use activities covering all costs.

Stipulations Necessary to Ensure Compatibility:

At present, unrestricted horseback riding occurs, primarily in and adjacent to the Indian Lakes area. Under Alternative C of the draft CCP-EIS, this area would be transferred, presumably to Churchill county, the city of Fallon, or the Fallon Paiute Shoshone tribe. If transferred, it is anticipated that existing uses would be allowed to continue in the Indian Lakes area, as well as, surrounding public lands managed by the Bureau of Land Management and Bureau of Reclamation.

Anticipated impacts described in the previous section suggest that unrestricted horseback riding would be inappropriate within Stillwater NWR relative to exotic seed encroachment, vegetative trampling, increases in stream sedimentation, and disturbance to wildlife resources. These impacts would be cumulative with associated impacts from other public use opportunities. However, if horseback riding is restricted to open roads only, anticipated impacts are not believed to exceed those already induced by vehicles, licensed all terrain vehicles (ATV's), and foot travel associated with other public use activities. Open roads would be subject to seasonal closures based on the presence of sensitive wildlife populations. Horse trailers would be restricted to designated parking areas outlined in the refuge brochure.

Determination:

This use has been found compatible*/not compatible (underline one).

* This use has been found compatible assuming adherence to the stipulations identified above. All circumstances cannot possibly be anticipated, and therefore, discretion must be left up to the refuge manager to manage the environmental horseback riding program within the framework of Alternative C of the Draft EIS.

Justification:

While not listed as a wildlife-dependent recreational activity under the National Wildlife Refuge System Improvement Act of 1997, horseback riding is believed to be a compatible public use under the stipulations outlined in this draft compatibility determination. Primary reasons for this determination include:

1. Horseback riding is an historic use at Stillwater NWR;
2. Wildlife observation is one element of horseback riding;
3. Horseback riding allows us to reach a target audience we may not reach through other activities; and
4. Impacts associated with horseback riding, as outlined in this compatibility determination, are not believed to exceed impacts already caused by other public use activities.

It is understood from the summary of anticipated impacts that many elements of the horseback riding program have the potential to detract from the Service's ability to achieve purposes outlined under Title II of Public Law 101-618. These impacts will be monitored and if they, or any as yet not-considered impacts are discovered, this compatibility determination would be reevaluated.

COMPATIBILITY DETERMINATION

Determination and Concurrence Signature Page

Refuge Determination

Prepared by: ____________________________ ____________
(Signature and Title) (Date)

Refuge Manager Approval: ____________________________ ____________
(Signature and Title) (Date)

Regional Office/California-Nevada Operations Office Concurrence

Refuge Supervisor: ____________________________ ____________
(Signature and Title) (Date)

Refuges & Wildlife PARD: ____________________________ ____________
(Signature and Title) (Date)

Geographic ARD/ CNO Manager: ____________________________ ____________
(Signature and Title) (Date)

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COMPATIBILITY DETERMINATION
--- DRAFT ---
(March 2000)

Use: Muskrat Trapping (Options 1 and 2 of Alternative C[1])

Refuge Name: Stillwater National Wildlife Refuge[2]

Establishing and Acquisition Authority(ies):

The Truckee-Carson-Pyramid Lake Water Rights Settlement Act of 1990 (Title II of Public Law 101-618) — Stillwater NWR.

Refuge Purpose(s):

Subsection 206(b)(2) of Public Law 101-618 expanded Stillwater NWR to its present approved boundary, and directed that the refuge "shall be managed by the Secretary through the United States Fish and Wildlife Service for the purposes of:

(A) maintaining and restoring natural biological diversity within the refuge;
(B) providing for the conservation and management of fish and wildlife and their habitats within the refuge;
(C) fulfilling the international treaty obligations of the United States with respect to fish and wildlife; and
(D) providing opportunities for scientific research, environmental education, and fish and wildlife oriented recreation."

The Refuge System Mission is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

Description of Use:

The muskrat trapping program under Alternative C of the Stillwater NWR Comprehensive Conservation Plan/Boundary Revision Draft EIS (Draft EIS) would allow the Service to use muskrat trapping as a management tool to the prevent muskrats from damaging refuge roads, levees, and water control structures. Damage would be assessed annually and as individual unit needs were identified, a cooperator would be selected through competitive bid. The cooperator would be issued a special-use permit to harvest a set number of muskrats (established through biological monitoring) within a designated area of the Stillwater NWR. This compatibility determination assumes that these same procedures would be used if refuge emergent habitats suffer excessive "eat-out" from overpopulation of muskrats. This will only occur if populations increase to a level where environmental damage and/or potential for disease outbreak (e.g., tularemia) are thought to exceed acceptable limits, and only after a study is undertaken to examine the relationships between muskrats and marsh ecology.

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[1] This is the first compatibility determination completed for muskrat trapping on the Stillwater NWR Complex. No compatibility determinations have been previously prepared for muskrat trapping on the area because the previous management authority for Stillwater NWR was different.

[2] To the extent that a boundary revision encompasses lands that are now within Fallon NWR, Stillwater Wildlife Management area and adjacent lands, this compatibility determination will cover all Federal lands within the new boundary of Stillwater NWR. Until the boundary is revised, this compatibility determination covers only those Federal lands that currently exist within Stillwater NWR and Fallon NWR.

Summary of Anticipated Impacts of the Use:

The purpose of this section is to critically and objectively evaluate the potential effects that the muskrat trapping program could have on the wildlife, habitat, and other public-use elements encompassed in refuge purposes, through the use of professional judgement and available information. The purpose of this section is not to show how the muskrat trapping program is compatible, as provisions to ensure compatibility are addressed elsewhere. Instead, potential impacts to habitat and wildlife resources will be addressed. Of key concern, then, is to maintain adverse impacts within acceptable limits. Therefore, one of the functions of this section is to point out whether adverse impacts are within or exceed these acceptable thresholds.

Background Information: In general, muskrats utilize a variety of strategies in marsh habitats ranging from selection of den sites (bank dens or emergent vegetation lodges), forage selection (emergent vegetation, submergent vegetation, algae, or woody plants; Willner et al. 1975), dispersal mechanisms (spring, relative to breeding range or water availability; fall, dispersion of young muskrats/water conditions), and breeding strategies (Weller et al. 1999). Typically short-lived (rarely more than two years, Bissell and Brown 1987), muskrats respond through high productivity with 2-3 litters produced annually (Boutin and Birkenholz 1987), and litter size ranging from 4-7 young (Boyce 1977). Muskrat density is highest where there is an equal distribution of emergent and submergent vegetation (Boutin and Birkenholz 1987); however, water level is likely more important as fluctuating levels tend to reduce habitat desirability to muskrats (Bellrose and Brown 1941, Bissell and Brown 1987).

The original muskrats inhabiting the Stillwater Marsh were predominantly bank dwelling strategists with the arrival of lodge building strategists occurring during 1949-50 (Marshall 1952). A tularemia outbreak eradicated the majority of the indigenous bank dwelling population at some point in the late 1940's with transplanted populations brought in from Tule Lake CA in 1949 (Horn 1949). This change in muskrat dwelling strategies was confirmed by local Paiute-Shoshone Indians who did not recognize the lodges forming within emergent vegetation communities (Marshall 1952). While it is believed that most of the original bank dwelling inhabitants have been locally extirpated (Fowler 1992), recent, light to moderate damage has been observed on some levee's within the Stillwater NWR (Neil Mansfield pers. comm.).

Lodge building strategies utilized by the transplanted muskrats have been advantageous to wetland habitats in Stillwater Marsh, for a variety of wildlife species. A 50:50 ratio of emergent to submergent vegetation (commonly referred to as the hemi-marsh), has been shown to provide for maximum avian species diversity and abundance (Weller and Spatcher 1965). Muskrats are integral to producing this mix as they clear dense stands of emergent vegetation through lodge building processes. Muskrats are prolific breeders and can rapidly reach population levels capable of producing eat-outs (Middleton 1990), which resemble open lake situations resulting in relatively low species diversity (Mitsch and Gosselink 1993). While this is a natural part of the marsh cycle (Weller 1978), populations capable of producing these eat-outs, are also subject to tularemia outbreaks (Horn 1949), which is transmittable to humans (Gordon et al. 1983).

Anticipated Impacts on the Service's Ability to Achieve Refuge Purposes: Widespread trapping, which has historically occurred throughout Stillwater Marsh, does not allow for muskrat herbivory to operate at natural levels. This is in conflict with the refuges establishing authority (Title II of P.L. 101-618) and is therefore, not consistent with management strategies outlined in Alternative C of the Draft EIS. Conversely, unregulated muskrat herbivory and population levels could result in unacceptable levels of infrastructure damage, reduction in extent and cycling of emergent habitats, and potential for tularemia outbreaks. Many researchers have considered muskrats a renewable resource, with surplus animals (based on compensatory mortality theory), available for harvest as a recreational and/or commercial use opportunity (see review in Boggess et al. 1990). Considering that muskrat herbivory is the second most important factor regulating marsh cycles (after water management; Weller 1978), these natural population fluctuations (which provide the harvestable segment of the muskrat population) are necessary to mimic processes essential to restoring and maintaining natural biological diversity on Stillwater NWR. Populations must be kept in check, only to the extent that they do not excessively damage infrastructure or cause disease potential to humans.

The prescribed muskrat trapping program would not be anticipated to have any measurable impact on muskrat abundance on the refuge since muskrats would only be trapped within 100 ft of roads and dikes under most circumstances. Therefore, this program would not impact our ability to conserve and manage fish, wildlife, and their habitats as outlined in P.L. 101-618 and integrated into Goal 1 of Alternative C of the Draft EIS. Exceptions would include muskrat population levels where disease outbreaks become possible. During most instances, it is anticipate that fewer than 3,000 individuals would be trapped in a given year.

Muskrat herbivory, and related effects to deep emergent and submergent habitat types, could aid in our ability to fulfill international treaty obligations with respect to fish and wildlife. As previously stated, muskrats tend to create openings in deep emergent vegetation, ultimately, creating a mix of deep emergent and submergent vegetation which provides forage and cover for migratory waterfowl during migration and wintering periods. Additionally, muskrat lodges have been found to provide habitat values for up to 60 vertebrate species (Kiviat 1978), helping to fulfill the intent of biodiversity initiatives. Therefore, muskrat trapping, outside of the prescribed trapping zones (within 100 feet of roads, dikes, and water-control structures), could potentially impair the Service's ability to manage for natural biological diversity; conservation of fish, wildlife, and their habitats; and fulfilling international treaty obligations with respect to fish and wildlife.

Considering the high turnover in muskrat populations and related high fecundity, it is not anticipated that the muskrat trapping program will have any adverse impacts to muskrat population levels, assuming that stipulations addressing harvest rates and trapping locations are observed. Muskrats tend to limit home range to within 5-10 m of their lodge and seldom move beyond 150 m of their lodge location (MacArthur 1978). Therefore, muskrat trapping within the specified 100 ft zone would allow the Service to control problem individuals without impacting natural levels of muskrat herbivory throughout the rest of the marsh. These sites would likely be recolonized during spring and/or fall dispersal as breeding territories are established (spring) or young move out of natal territories (fall). This exemplifies the need for annual monitoring to detect recolonization rates, continuing damage problems, and ultimately, success of management strategy implementation.

Natural levels of muskrat herbivory at Stillwater NWR remains largely undocumented, with anecdotal information used to infer muskrat importance to the Stillwater Marsh system. While it is largely understood that this is an important component of natural marsh cycling, it is also possible that overpopulation (resulting from optimal habitat and forage conditions; Boutin and Birkenholz 1987), could result in consumption of all available vegetation, potentially, affecting the root system and future germination by deep emergent vegetation for several years (Perry 1982). A study will be initiated to elucidate relationships between Stillwater Marsh ecology and muskrat herbivory, potentially allowing muskrat populations to climb, without control, to examine impacts relative to this phenomenon.

Public Involvement:

Muskrat trapping is one of the issues being addressed in the comprehensive conservation planning process. Three public scoping meetings were conducted during March 1997 by the

Department of the Interior for several potential Federal actions, including comprehensive planning at the Stillwater NWR Complex. They were conducted in Fallon, Fernley, and Reno. Six open-house workshops were conducted specifically for Stillwater NWR Complex comprehensive planning. One meeting was held in Fallon and one in Reno during each of the months March, April, and July 1997. The Service met periodically with the Nevada Division of Wildlife.

Additional public involvement will occur before compatibility determination is finalized.

Availability of Resources:

Direct costs to administer the muskrat trapping program are primarily in the form of staff time. It is estimated that the following level of involvement by refuge staff will be required to adequately manage and monitor the muskrat trapping program over the long term:

Position and GS/WG Level	Involvement	FTE	Cost
Project Leader/Deputy Project Leader (GS-12/13)	Oversight, coordination with public use groups	0.01	$664
Wildlife Biologist (GS 11)	Coordinate muskrat trapping program	0.05	$2,836
Wildlife Biologist (GS 09/11)	Biological monitoring to examine the extent of structural damage	0.05	$2,734
GIS Specialist (GS 11)	Complete maps to delineate extent of muskrat herbivory	0.05	$2,734
Law Enforcement Officer (GS-09/ WG-09)	Law enforcement	0.01	$448
Total FTEs and Costs:		0.17	$9,416

Stipulations Necessary to Ensure Compatibility:

Under Alternative C of the Draft EIS, muskrat trapping will be considered a management tool used primarily to protect the refuge's water distribution infrastructure, and secondarily to regulate distribution of dense emergent habitat zones and prevent disease outbreaks, potentially transmittable to the general public. Parameters surrounding implementation of the latter program will be based on biological monitoring strategies outlined in the stations biological monitoring plan and will result from research conducted to examine muskrat herbivory's role in the Stillwater Marsh ecosystem. In the interim, muskrat trapping will be regulated under the following two stipulations:

1. Muskrat trapping will be limited to areas where excessive infrastructure damage has occurred.
2. Trapping will be limited to within 100 feet of affected dikes, roads, or water control structures

Levees and road beds will be periodically monitored to survey the extent of muskrat den occurrence throughout the refuge infrastructure with initial efforts intended to document existing density/linear mile of levee. As this baseline density is surpassed, an assessment as to whether control efforts should be initiated will be made including an economic evaluation of the costs associated with restoration of the segment of levee being surveyed. If trapping is deemed to be a suitable management action, then muskrat trapping will be contracted out through competitive bid, and restricted within 100 ft of the affected segment of levee. Subsequent analysis of continuing levels of impact will be completed to determine whether the proposed action was adequate to minimize damage or whether alternative approaches are necessary to curtail the problem.

Habitat objectives or ranges in habitat type distribution have been described in Alternative C of the Draft EIS. As habitat proportions drop below the lower value in the distribution range for distribution of deep and/or shallow emergent habitats (15% and 10% of total refuge wetland habitat, respectively), then an assessment would be conducted relative to possible reasons why this shortfall has occurred. If muskrats are considered the primary factor related to declines, then muskrat trapping (along with water management, and other available habitat management tools), will be evaluated as a possible action to increase emergent habitat. If selected, specific wetland units will be targeted for muskrat control efforts, with lodge abundance (number of lodges/acre) used as an index of muskrat population levels. Initial sampling efforts will be used to establish baseline levels, which when exceeded, will trigger an analysis of muskrat trapping applicability. If deemed an appropriate management strategy, then muskrat trapping will be confined to targeted wetland units with no restrictions on trap distance to shoreline.

Determination:

This use has been found compatible*/not compatible (underline one).

* This use has been found compatible assuming adherence to the stipulations identified above. All circumstances cannot possibly be anticipated, and therefore, discretion must be left up to the refuge manager to manage the environmental education and interpretation program within the framework of Alternative C of the Draft EIS.

Justification:

Muskrat population cycling and herbivory are natural elements of marsh succession and should be allowed to occur to the extent that they do not interfere with efficient water management and do not create a potential public health hazard relative to disease transmission. Considering that the magnitude and timing of other natural processes involved in the functioning of the Stillwater Marsh system have been reduced and/or altered, it is prudent to use habitat management tools, including muskrat trapping, to minimize impacts associated with the altered system. Muskrat trapping, within the parameters outlined under Alternative C of the Draft EIS, is primarily needed on Stillwater NWR to prevent excessive damage to dikes, roads, water control structures, and other water management facilities. Absence of control measures could result in frequent and costly repairs to these facilities. By removing a relatively low number of animals, which would likely not affect the overall population, these problems could be avoided. Although muskrats would be allowed to graze on emergent vegetation, unabated for the most part, muskrat control measures may be determined to be necessary while emergent vegetation is recovering in certain units, or possibly to avoid overgrazing by muskrats if this is deemed undesirable through further study.

COMPATIBILITY DETERMINATION

Determination and Concurrence Signature Page

Refuge Determination

Prepared by: ______________________________ (Signature and Title) ____________ (Date)

Refuge Manager Approval: ______________________________ (Signature and Title) ____________ (Date)

Regional Office/California-Nevada Operations Office Concurrence

Refuge Supervisor: ______________________________ (Signature and Title) ____________ (Date)

Refuges & Wildlife PARD: ______________________________ (Signature and Title) ____________ (Date)

Geographic ARD/ CNO Manager: ______________________________ (Signature and Title) ____________ (Date)

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COMPATIBILITY DETERMINATION
— DRAFT —
(March 2000)

Use: Livestock Grazing (Alternative C[1])

Refuge Name: Stillwater National Wildlife Refuge[2]

Establishing and Acquisition Authority(ies):

The Truckee-Carson-Pyramid Lake Water Rights Settlement Act of 1990 (Title II of Public Law 101-618) — Stillwater NWR.

Refuge Purpose(s):

Subsection 206(b)(2) of Public Law 101-618 expanded Stillwater NWR to its present approved boundary, and directed that the refuge "shall be managed by the Secretary through the United States Fish and Wildlife Service for the purposes of:

(A) maintaining and restoring natural biological diversity within the refuge;
(B) providing for the conservation and management of fish and wildlife and their habitats within the refuge;
(C) fulfilling the international treaty obligations of the United States with respect to fish and wildlife; and
(D) providing opportunities for scientific research, environmental education, and fish and wildlife oriented recreation."

The Refuge System Mission is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

Description of Use:

The amount of livestock grazing that occurs on Stillwater NWR will differ from year to year, with many years requiring no use of livestock to achieve management objectives. In most years, total use would be less than 500 AUMs. Permits for livestock grazing would thus be solicited and issued only on a short-term basis, usually on a year-to-year basis. Although no critical or overriding needs have been identified for the use of livestock on Stillwater NWR, the potential use of livestock was retained to provide managers with "another tool in the toolbox." Therefore, livestock use on Stillwater NWR cannot be described in absolute terms; rather, it is described in terms of possible applications (e.g., using words like "may" or "could"). For this reason, and because anything but a very carefully implemented, controlled, and monitored livestock grazing program has the potential to cause significant adverse impacts to the Stillwater NWR ecosystems, most of the detail of this compatibility determination is provided in the "Stipulations to Ensure Compatibility" section. Published literature on the effects of cattle and the potential use of livestock for achieving habitat objectives was reviewed (Appendix M). The uses identified below were based in part on this review.

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[1] This is the first compatibility determination completed for livestock grazing on the Stillwater NWR Complex. No compatibility determinations have been previously prepared for this activity on the area because the previous management authority for Stillwater NWR was different.

[2] To the extent that a boundary revision encompasses lands that are now within Fallon NWR, Stillwater Wildlife Management area and adjacent lands, this compatibility determination will cover all Federal lands within the new boundary of Stillwater NWR. Until the boundary is revised, this compatibility determination covers only those Federal lands that currently exist within Stillwater NWR and Fallon NWR.

Of the available classes of livestock, goats and sheep hold the most promise for controlling broad-leaved weeds, and cattle generally would be the least effective for this purpose (Lacey 1987, Brock 1988, USBLM 1991), primarily due to their respective predisposition to feed on particular food groups (Hanley 1982, Provenza and Balph 1987 as cited by Stuth 1991). Compared to goats and sheep, cattle would be the most effective in reducing the cover and height of grasses and grass-like vegetation (Hanley and Hanley1982, Brock 1988, Stuth 1991).

Goats and Sheep

Following completion and approval of an integrated pest management plan (IPM), goats or Sheep may be used to selectively graze or browse noxious weeds under highly confined and controlled conditions. Distribution of goats and sheep would be limited to the specific site being treated, by electric fences or by other means. Habitat-types in which this application could be used include riparian areas including canal banks, marsh shorelines, meadows, and agricultural fields. Season of use would vary, but generally would occur during the peak growing season (e.g., March-July).

Cattle

Cattle could be used on occasion by contracting-farmers to control weeds in the agricultural fields and along ditches in the vicinity of the agricultural fields in which they are performing services for the Service (west of Hunter Road and south of the Canvasback Gun Club).

Cattle could be used occasionally or annually to enhance goose browse in refuge agricultural fields (west of Hunter Road and south of the Canvasback Gun Club) in years when water is available for irrigation. In this application, cattle would be grazed until September or October. Key wildlife species in the treatment areas include Canada geese and other waterfowl species.

When other techniques are not feasible, cattle could be used to create openings in overly-dense emergent vegetation wetland units. This would be done during the growing season. At present, there is no need for this use. However, there may be use for this application in the future when emergent-marsh communities have recovered. Applications of this use would be done with the recognition that extensive stands of dense emergent vegetation with accumulations of dead-plant material is a natural component of the ecosystem. Key species and groups of species would include redheads, cinnamon teal, mallards, gadwalls, and other waterfowl, white-faced ibis, American bitterns, soras, Virginia rails, and marsh wrens.

When prescribed burning is not feasible, cattle may also be used irregularly to reduce or trample accumulations of dead plant material in meadows and other grassland habitats (not including Indian ricegrass communities and other upland plant communities subsisting on local precipitation). Prescribed burning would be used for this purpose in most cases. Key species and groups of species in treatment areas would include small mammals, passerine birds, and waterfowl (nesting).

Total use by cattle on the refuge would not exceed 500 AUMs in any given year.

Anticipated Impacts of the Use:

The potential impacts of Alternative C's livestock grazing program on the Service's ability to achieve refuge purposes and the Refuge System mission are evaluated in detail in Tab A of this notebook and summarized below. The following discussion is divided into major components of refuge purposes and the mission of the Refuge System. The detailed discussion in Tab A and literature review on the effects of livestock grazing on habitat and wildlife (Appendix M of the Draft EIS) should be consulted for more detailed information.

As prescribed under Alternative C, grazing by goats and sheep would enhance the Service's ability to approximate a natural abundance and distribution of plants and animals on Stillwater NWR by contributing to the reduction of noxious weeds. Goats and sheep have been successfully been used in many situations to control broad-leaved weeds (Lacey 1987, Brock 1988), and sheep may have fewer adverse impacts to riparian areas (Glimp and Swanson 1994). Using sheep and goats to control noxious weeds on particular sites would likely adversely impact non-target species of plants within the fenced area, which may be unavoidable. However, to the extent that grazing by goats and sheep is successful in reducing the composition and cover of noxious weeds, native vegetation will benefit in the long term (thus enhancing natural vegetative diversity).

Feeding habitat for Canada geese on refuge farmlands will be enhanced by periodic grazing by cattle (assuming that water becomes available for irrigating these lands). Enhancing goose foraging habitat through the use of cattle has been noted by several authors (e.g., Rouse 1955, Greenwalt 1978). Few adverse impacts to wildlife would be anticipated in the agricultural area, assuming that the fields continue to be farmed. Negligible impacts would be expected with respect to approximating natural biological diversity on Stillwater NWR because the agricultural area contributes minimally toward this goal and few lands will remain in agricultural production.

Creating openings in extensive stands of dense emergent vegetation can enhance nesting and brooding habitat for a variety of waterbirds, possibly allowing some birds to occupy the habitat that otherwise would not venture into the site, and it could increase the within-community diversity of wildlife. Conversely, the action would adversely impact species associated with extensive stands of dense emergent vegetation and may detract from the natural biological diversity of the area. In addition to temporary openings in stands of emergent vegetation, cattle grazing has the potential to reduce plant vigor (Taylor 1986, Clary and Webster 1989, Platts 1989), which can result in changes in composition of wetland communities (Hargis and McCarthy 1986, Young 1986, Kovalchik 1987), thus creating longer-term openings in vegetation. When it is used specifically to create openings to mimic the effects of flooding (e.g., creation of openings down the center of the marsh), cattle grazing would contribute to the approximation of natural vegetative diversity. Although grazing by large ungulates historically did not influence vegetative structure in Stillwater Marsh to any great extent (Young et al. 1976, Mack and Thompson 1982, Miller et al. 1994), cattle grazing, as well as disking and prescribed burning, could be used to mimic the effects of large flood events that likely opened the interior of the marsh along major flow routes. The ability to recreate flood events will be very limited due to the limited availability of water and limited canal capacity (Appendix N of Draft EIS). Disking and prescribed burning would be the preferred methods. When cattle are used to create openings in emergent vegetation close to the shoreline to benefit particular species of waterbirds (see Factor 2.c), it would tend to reduce natural vegetative diversity.

Using cattle to create openings has the potential to reduce the quality of shoreline habitat for species associated with dense cover of grasses and other shoreline vegetation. This is an especially important consideration given the significant reduction of this habitat in the Lahontan Valley and throughout the West. This adverse effect should be minor under Alternative C because electric fences or other means will be used to prevent cattle from using shoreline areas. If use of shoreline vegetation cannot be kept below 10 percent at any given site (not measured as a whole over the entire length of shoreline), another technique would be sought for creating openings.

Reducing or trampling accumulations of dead plant material in meadow-type habitats, when done infrequently (no more than once every 6-7 years), could in some situations improve the health of the herbaceous vegetation and result in denser, taller vegetative cover after several years of regrowth (this likely does not apply to saltgrass). Except for the few years following treatments, this would benefit some species of nesting birds. However, because extensive areas of residual vegetation was likely a component of the natural vegetative structure, this activity would tend to diminish natural biological diversity and could adversely affect certain small mammal species and other wildlife associated with dense, rank herbaceous vegetation. A component of floodplain meadows and other grassland areas that facilitates nesting success of waterfowl is the presence of tall, dense vegetation (Kirsch 1969, Braun et al. 1978, Kirby et al. 1992, Gilbert et al. 1996), and to the extent that meadow habitat is grazed, it could negatively affect some small mammal species and other wildlife associated with dense, rank herbaceous vegetation (Kauffman et al. 1982, Medin and Clary 1989, 1990, Charlet et al. 1998) and could impair waterfowl nesting success (Braun et al. 1978, Kirby et al. 1992, Gilbert et al. 1996) in the short term.

Because the livestock grazing program of Alternative C would enhance riparian habitat (through control of noxious weeds) and would enhance feeding habitat of several viewable wildlife species, it would contribute to viewing opportunities for the visiting public. Additionally, using livestock to manage wildlife habitat would present an opportunity to interpret this aspect of wildlife management, further enhancing the public's understanding of how wildlife and their habitats are managed.

The livestock grazing program under Alternative C will only have limited negative effects on environmental education, wildlife observation, and other wildlife-dependent recreational uses on Stillwater NWR. Because livestock grazing would occur infrequently in most cases, and in all cases would be of short duration in localized areas, most visitors would not see livestock on the refuge. Interior fences would eventually be removed, negating this potential effect on refuge visitors' experiences. Thus, the positive aspects of the livestock grazing program with respect to wildlife-dependent recreational uses would outweigh the negative aspects.

Public Involvement:

Livestock grazing is one of the issues being addressed in the comprehensive conservation planning process. Three public scoping meetings were conducted during March 1997 by the Department of the Interior for several potential Federal actions, including comprehensive planning at the Stillwater NWR Complex. They were conducted in Fallon, Fernley, and Reno. Six open-house workshops were conducted specifically for Stillwater NWR Complex comprehensive planning. One meeting was held in Fallon and one in Reno during each of the months March, April, and July 1997. The Service met periodically with the Nevada Division of Wildlife. Livestock grazing was identified as an issue in several of these meetings.

Two livestock grazing tours were conducted whereby the Service received input from a variety of professionals and interest groups. Several comments that the Service received on the *Draft Environmental Impact Statement for Water Rights Acquisition for Lahontan Valley Wetlands*, which included comments on livestock grazing, were also incorporated as input for the Service to consider in developing a CCP for the Stillwater NWR Complex.

Additional public involvement will occur before compatibility determination is finalized.

Availability of Resources:

Costs to administer the livestock grazing program will mostly be salaries, but will also require monitoring equipment including exclosures. It is estimated that 0.1 FTE at the GS-11 level, 1 FTE at the GS-05/07 level, 0.05 FTE at the WG-08 level, and 0.01 FTE at the GS-12/13 level will be required (an estimated $11,000). Staff time will be spent writing pertinent step-down plans, developing and administering contracts, monitoring livestock grazing operations, monitoring habitat condition and progress toward objectives, ensuring that prescriptions are being followed, and writing progress reports and recommendations. Needed monitoring equipment and facilities, and vehicle use is estimated to be about $5,000. Priority will be given to using livestock for controlling noxious weeds if livestock are determined to be an effective control for this.

No additional facilities will be required. Any necessary fencing or other facility will be supplied by the livestock grazing permittee.

Stipulations Necessary to Ensure Compatibility:

Published literature on the effects of cattle and the potential use of livestock for achieving habitat objectives was reviewed (see attached literature review). The stipulations were based in part on this review.

Goats and Sheep

Goats and sheep would only be permitted on the refuge for use in controlling noxious weeds and only when used to accomplish specific, pre-defined objectives identified in an approved IPM. When goats and sheep are not actively being used for this purpose, they will not be permitted on refuge lands — goats and sheep will not be accommodated for more than 1 day after a particular application has been completed or between applications separated in time.

In all cases, monitoring would be appropriately designed and carried out to ascertain the effectiveness of using goats or sheep to accomplish the particular objective. Desired vegetation conditions will be specifically outlined, and when grazing by goats or sheep has achieved the desired conditions, they will be removed (thus, frequent monitoring will be needed). Goats and sheep may also be removed if they are causing unexpected adverse impacts, or cannot be confined to the project area (below).

In all applications, goats and sheep will be confined to a pre-defined "project area" and will be kept out of sensitive and other non-target areas using electric fences, herding, or other technology. The project area will not exceed the distribution of the weed patch they are being used to control.

When the objective of the treatment is not to completely denude a project area of vegetation, goats or sheep will only be used if it is demonstrated or can be reasonably assumed that they will selectively feed on the target species rather than the native vegetation on the site.

Cattle

Fences currently do not exist to keep cattle out of several areas of Stillwater NWR (Nevada is an open-range state). Thus, cattle grazing as currently managed (under the 1948 Tripartite Agreement) would be phased out as boundary fences are constructed. It is anticipated that this will take about 3 years following implementation of the CCP.

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Upon completion of boundary fencing sufficient to keep cattle off of refuge lands and concurrent cessation of the current livestock grazing program, the following stipulations will be placed on the livestock grazing program implemented under the CCP.

Cattle would only be permitted on the refuge when used to accomplish a specific, pre-defined objective identified in the approved CCP or step-down management plan addressing CCP objectives in more detail. Uses would be limited to those identified under "Description of Uses." When cattle are not actively being used for such purposes, they will not be permitted on refuge lands — cattle will not be accommodated for more than 1 day after an application has been completed or between applications separated in time.

In all cases, except possibly in and along agricultural fields, monitoring would be appropriately designed and carried out to ascertain the effectiveness of using cattle to accomplish a particular objective. In all cases, distribution and actual use would be recorded for each use of cattle grazing each year.

Aside from two exceptions, duration of use in any given location will not exceed 1 month, following the concept of short-duration, high intensity use. Longer durations would only prolong and exacerbate the negative effects of cattle grazing, thus offsetting the intended benefits. (If haying, prescribed burning, or disking were used to accomplish the same objective, there would be no needed for repeated treatments over the course of 1 month.) An objective then is to introduce enough cattle into the treatment area to accomplish the task in as short of time as possible. Prescriptions, therefore, must be appropriately designed to accommodate this constraint. Desired vegetation conditions will be specifically outlined, and when cattle grazing has achieved the desired conditions, they will be removed (thus, frequent monitoring will be needed). Cattle may also be removed if they are causing unexpected adverse impacts or cannot be confined to the project area (below). The exceptions are that (1) cattle may remain on farm fields for longer than 1 month if necessary, and (2) cattle may remain in an emergent marsh if the specific application calls for the reduction in vigor of emergent vegetation. In no cases will cattle be permitted on meadows and other grassland habitats for more than 1 month.

In all applications, cattle will be confined to a pre-defined "project area" and would be kept out of sensitive and other non-target habitats using electric fences or other technology. When used to create openings in emergent vegetation, cattle must be confined to the emergent vegetation zone of marshes; cattle cannot be permitted to access shoreline areas not dominated by emergent vegetation. If this technique cannot be designed and implemented without resulting in less than 10% use of saltgrass and other shoreline vegetation, another technique must be used. Use of cattle to create openings in emergent vegetation must recognize that dense stands of emergent vegetation is a natural component of Stillwater Marsh, and that extensive stands of dense emergent vegetation, in which dead plant material is permitted to accumulate, must be maintained.

Use of cattle to reduce or trample accumulations of dead plant material in meadows and other grass-dominated communities must similarly recognize that "rank" vegetation is a natural part of these communities, and that extensive areas will be maintained in this condition. In recognition of this, however, it may be decided that accumulations of dead plant material may be needed in a particular meadow or other grass-dominated community. If prescribed burning, the more applicable technique, is not feasible, cattle may be used for this purpose. In no cases will reduction of accumulated dead plant material in meadows and other grass-dominated communities be repeated more often than once every 5 years, regardless of technique used (including cattle grazing, prescribed burning).

Use of cattle for any uses not described under "Description of Use" would not be permitted without substantive scientific information demonstrating that (1) cattle would be the most effective tool to accomplish the objective at hand, (2) the desired conditions are needed to accomplish one or more objectives identified in the CCP, and (3) the prescribed use of cattle would not measurably adversely impact native vegetation or native plant or animal communities.

Without substantive evidence demonstrating that successful use of cattle to control cheatgrass or broad-leaved weeds in similar environmental conditions as Stillwater NWR without measurable impacts to native vegetation, cattle would not be used to control cheatgrass or broad-leaved weeds. As summarized in Appendix M of the Draft EIS, the prevailing information indicates that cattle would not be effective for these purposes.

No data was found to indicate that cattle would foster or speed recovery of the following habitats, and therefore, they would not be used or permitted in the habitats: (1) riparian areas (including the Carson River and Stillwater Slough), (2) salt desert shrub communities, or (3) stabilized or unstabilized dunes. When cattle are used for any purpose on Stillwater NWR, the management action will be designed and implemented in a way that will not permit cattle to enter these areas for any period of time.

Livestock - General

Grazing by any other class of livestock (other than cattle, goats, and sheep, as specified above) will not be permitted on Stillwater NWR.

Determination:

This use has been found compatible*/not compatible (underline one).

* This use has been found compatible assuming adherence to the stipulations identified above. All circumstances and perceived needs for livestock cannot possibly be anticipated, and therefore, discretion must be left up to the refuge manager to follow the philosophy of management outlined in the CCP and only allow uses of livestock that are consistent with this philosophy. Of primary consideration is that the focus of management is on the approximation of natural conditions and restoration and maintenance of natural biological diversity. Because biotic processes and their variability is a component of natural biological diversity, natural levels, rates, and extent of herbivory must be considered in deciding whether to use livestock for any given purpose.

Justification:

Use of goats and sheep to control noxious weeds would, to the extent it is effective, reduce the composition of these nonnative plants in plant communities and would reduce their expansion and spread to other locations. Numerous examples exist on the successful use of goats and sheep to reduce broad-leaved weeds, especially when done as part of an integrated program. This application will be important in increasing the composition of native vegetation in plant communities and the approximation of natural habitat conditions. It will also be important in enhancing nesting habitat of some species. Therefore, use of goats and sheep as described in this compatibility determination would contribute toward purposes of Stillwater NWR (e.g., natural biological diversity, international treaty obligations), and it would result in few detrimental side-effects.

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Use of cattle to enhance palatability and availability of forage in agricultural fields for wintering Canada geese, including the use of cattle to control weeds in agricultural fields and along ditches (which facilitates farming primarily aimed at providing winter forage for geese) would enhance goose foraging habitat on the refuge, and there are few if any detrimental impacts on the approximation of natural habitat conditions and natural biological diversity (which addresses two other purposes), because the refuge farmlands will not contribute to this goal anyhow. Use of cattle to create openings in emergent vegetation would, to the extent that it is successfully done, enhance nesting and brooding habitat for waterfowl and certain other waterbirds, and depending on the application prescription may also enhance natural vegetative diversity. It is recognized that there are more effective ways of reducing emergent vegetation, but cattle grazing would be maintained as an option. It is possible that cattle grazing could be used to rejuvenate meadow and other grass-dominated communities to enhance waterfowl nesting habitat, but because it is also possible that it would diminish the quality of nesting habitat, care must be taken in developing and implementing the prescription. This application holds the most potential for conflicting with other purposes, so a well-designed monitoring program will be necessary. All of these uses of cattle, therefore, would contribute generally to the Refuge System mission, the second-listed purpose of Stillwater NWR (conservation of wildlife and their habitat), and the North American Waterfowl Management Plan. Furthermore, enhancing goose forage also has the potential of enhancing wildlife-dependent recreation opportunities on the refuge, the fourth-listed purpose of the refuge.

A literature review was conducted in which the potential uses of livestock grazing were evaluated against Stillwater NWR goals and purposes, and effects were examined. This literature review is provided in Appendix M of the Draft EIS.

Use of cattle for any uses not described under "Description of Use" would not be permitted without substantive scientific information demonstrating that (1) cattle would be the most effective tool to accomplish the objective at hand, (2) the desired conditions are needed to accomplish one or more objectives identified in the CCP, and (3) the prescribed use of cattle would not measurably adversely impact native vegetation or native plant or animal communities.

Without substantive evidence demonstrating that successful use of cattle to control cheatgrass or broad-leaved weeds in similar environmental conditions as Stillwater NWR without measurable impacts to native vegetation, cattle would not be used to control cheatgrass or broad-leaved weeds. As summarized in Appendix M of the Draft EIS, the prevailing information indicates that cattle would not be effective for these purposes.

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Determination:

This use has been found compatible*/not compatible (underline one).

* This use has been found compatible assuming adherence to the stipulations identified above. All circumstances and perceived needs for livestock cannot possibly be anticipated, and therefore, discretion must be left up to the refuge manager to follow the philosophy of management outlined in the CCP and only allow uses of livestock that are consistent with this philosophy. Of primary consideration is that the focus of management is on the approximation of natural conditions and restoration and maintenance of natural biological diversity. Because biotic processes and their variability is a component of natural biological diversity, natural levels, rates, and extent of herbivory must be considered in deciding whether to use livestock for any given purpose.

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Use of goats and sheep to control noxious weeds would, to the extent it is effective, reduce the composition of these nonnative plants in plant communities and would reduce their expansion and spread to other locations. Numerous examples exist on the successful use of goats and sheep to reduce broad-leaved weeds, especially when done as part of an integrated program. This application will be important in increasing the composition of native vegetation in plant communities and the approximation of natural habitat conditions. It will also be important in enhancing nesting habitat of some species. Therefore, use of goats and sheep as described in this compatibility determination would contribute toward purposes of Stillwater NWR (e.g., natural biological diversity, international treaty obligations), and it would result in few detrimental side-effects.

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COMPATIBILITY DETERMINATION

Determination and Concurrence Signature Page

Refuge Determination

Prepared by: ______________________ (Signature and Title) __________ (Date)

Refuge Manager Approval: ______________________ (Signature and Title) __________ (Date)

Regional Office/California-Nevada Operations Office Concurrence

Refuge Supervisor: ______________________ (Signature and Title) __________ (Date)

Refuges & Wildlife PARD: ______________________ (Signature and Title) __________ (Date)

Geographic ARD/ CNO Manager: ______________________ (Signature and Title) __________ (Date)

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COMPATIBILITY DETERMINATION

--- DRAFT ---

(March 2000)

Use: Farming (Options 1 and 2 of Alternative C[1])

Refuge Name: Stillwater National Wildlife Refuge[2]

Establishing and Acquisition Authority(ies):

The Truckee-Carson-Pyramid Lake Water Rights Settlement Act of 1990 (Title II of Public Law 101-618) — Stillwater NWR.

Refuge Purpose(s):

Subsection 206(b)(2) of Public Law 101-618 expanded Stillwater NWR to its present approved boundary, and directed that the refuge "shall be managed by the Secretary through the United States Fish and Wildlife Service for the purposes of:

(A) maintaining and restoring natural biological diversity within the refuge;
(B) providing for the conservation and management of fish and wildlife and their habitats within the refuge;
(C) fulfilling the international treaty obligations of the United States with respect to fish and wildlife; and
(D) providing opportunities for scientific research, environmental education, and fish and wildlife oriented recreation."

The Refuge System Mission is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

Description of Use:

By cooperative agreement, farming would be allowed to occur on up to 200-300 acres annually, to provide forage for herbivorous, migratory and resident wildlife. Only historically cropped lands would be available for planting, primarily those lands within Stillwater NWR boundaries located south of the Canvasback Gun Club, north of Stillwater Road, and west of Hunter Road Only alfalfa, winter rye, winter wheat, or other crops anticipated to benefit native herbivorous species would be planted on these sites. All farming would be conducted by private farmers, under a cooperative agreement which outlines the type of crop and amounts to be left for wildlife purposes. Water rights to irrigate crops planted on Stillwater NWR lands would be transferred by the cooperator (e.g., temporary transfer of water rights place of use) since water rights acquired and transferred to Stillwater NWR are to be used only for the maintenance of wetland habitat for wildlife.

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[1] This is the first compatibility determination completed for farming on the Stillwater NWR Complex. No compatibility determinations have been previously prepared for farming on the area because the previous management authority for Stillwater NWR was different.

[2] To the extent that a boundary revision encompasses lands that are now within Fallon NWR, Stillwater Wildlife Management area and adjacent lands, this compatibility determination will cover all Federal lands within the new boundary of Stillwater NWR. Until the boundary is revised, this compatibility determination covers only those Federal lands that currently exist within Stillwater NWR and Fallon NWR.

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Summary of Anticipated Impacts of the Use:

The purpose of this section is to critically and objectively evaluate the potential effects that the farming program could have on the wildlife, habitat, and other public-use elements encompassed in refuge purposes, through the use of professional judgement and available information. The purpose of this section is not to show how the farming program is compatible, as provisions to ensure compatibility are addressed elsewhere. Instead, potential impacts to habitat and wildlife resources are addressed. Of key concern, then, is to maintain adverse impacts within acceptable limits. Therefore, one of the functions of this section is to point out whether adverse impacts are within or exceed these acceptable thresholds.

With an estimated 34,955 acres of agricultural land in Churchill County (Churchill County Assessors Office), an additional 200-300 acres of cropland for Canada geese would not add significantly to this acreage base. Nevertheless, there are some positive effects of providing this cropland on the refuge with respect to refuge goals, one of which calls for contribution to fulfilling provisions in international bird conservation plans. Canada geese, the primary beneficiary of the farming program, and are considered a key species in the Intermountain West Joint Venture Implementation Plan (1995), which stems from the North American Waterfowl management plan (1986). One objective of the Implementation Plan is to provide "...wintering habitat to maintain a midwinter population of 90,000 Canada geese." Because Canada geese in the Lahontan Valley rely heavily on agricultural crops for forage, and because the refuge's farmland is close to a key loafing/staging wetland (Stillwater Point reservoir), Canada geese would benefit from implementation of this program.

Canada geese have adapted to a variety of winter forage types including agricultural crops, moist-soil vegetation, native meadow, and other wetland habitat types (Bellrose 1980, Petrie et al. 1998). All of these forage types provide different nutrients and available energy, with a mix of all habitat types suggested to provide for the winter requirements of Canada geese (Petrie et al. 1997, Petrie et al. 1998). Approximately 6,000 Canada geese use Lahontan Valley on an annual basis (Bellrose 1980), thus, providing forage crops for Canada geese on refuge lands would contribute to the Service's ability to provide secure, relatively undisturbed feeding areas for this species, and other herbivorous species inhabiting Stillwater NWR. Therefore, the farming program would contribute to the second purpose of the refuge, which is to conserve and manage fish, wildlife, and their habitat.

Because water acquired by the Service would not be used for farming purposes, the farming program would not have any effects on the Service's ability to approximate natural biodiversity and conserve wildlife in the existing parts of Stillwater Marsh. However, because the farmland area is in the historic Stillwater Slough floodplain, farming could hamper efforts to restore floodplain habitat and other wetlands in this limited area, which could impair the restoration of native biotic communities associated with this habitat. This would impact achievement of the first purpose of the refuge, given the emphasis on restoration of natural biodiversity, habitat, and ecosystems.

Species richness is not anticipated to be affected. It is not clear whether higher use of the Lahontan Valley by Canada geese resulting from farming would contribute to approximation of natural biological diversity, as historic population levels (pre-1850) are unknown. It appears that white-faced ibis populations increased after the introduction of flood-irrigation agriculture in the valley (Fowler 1982), which would deviate from natural biological diversity. Croplands tend to result in lower measures of biological diversity, with fewer species documented in agricultural habitats as opposed to grasslands (Lokemoen and Baiser 1997). Reasons for this range from soil disturbance (Higgins 1977) to chemical toxicity (Hill and Fleming 1982) with cover type homogeneity also adding to lower species diversity. While conflicts with natural biological diversity principles are evident, benefits received by sensitive species (white-faced ibis), birds covered under international bird conservation

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plans (Canada geese), and resident wildlife species (mule deer), would be consistent with the second and third purposes for refuge establishment, and would occur on a limited area.

Cumulative impacts associated with implementation of the farming program are believed to be negligible, as farming would only occur on lands historically in agricultural production.

Public Involvement:

Farming is one of the issues being addressed in the comprehensive conservation planning process. Three public scoping meetings were conducted during March 1997 by the Department of the Interior for several potential Federal actions, including comprehensive planning at the Stillwater NWR Complex. They were conducted in Fallon, Fernley, and Reno. Six open-house workshops were conducted specifically for Stillwater NWR Complex comprehensive planning. One meeting was held in Fallon and one in Reno during each of the months March, April, and July 1997.

Additional public involvement will occur before compatibility determination is finalized.

Availability of Resources:

Direct costs to administer the farming program are primarily in the form of staff time. It is estimated that the following level of involvement by refuge staff will be required to adequately manage and monitor the farming program over the long term:

Position and GS/WG Level	Involvement	FTE	Cost
Project Leader/Deputy Project Leader (GS-12/13)	Oversight, coordination with cooperators	0.02	$1,328
Wildlife Biologist (GS 11)	Establishing and implementing cooperative agreements	0.05	$2,836
Administrative support Assistant (GS-07)	Provide General Administrative Support	0.01	$407
Total FTEs and Costs:		0.08	$4,571

Other potential costs could include purchase of seeds and minimal maintenance of delivery canals and roads. Estimates could approach an additional $5,000 distributed among these other costs for a total of $9,571 to annually implement the farming program.

Stipulations Necessary to Ensure Compatibility:

Farming on Stillwater NWR will only occur on previously cropped lands located south of the Canvasback Gun Club, north of Stillwater Rd., and west of Hunter Rd, on a maximum of 300 acres of land. All farming will be accomplished by private cooperators with terms of agreement stipulating type of crop and appropriate uses. Allowed crops include alfalfa, winter wheat, winter rye, and alternative natural forage plants suggested by the USDA-NRCS. Other crops including corn, oats, and sudan grass would be considered on a case by case basis. Uses include cropping, and in some instances, livestock grazing to provide optimal vegetative height for goose grazing. Generally, cooperators will assume all maintenance and operational costs associated with farming including maintenance of all water conveyance systems and use of cooperators farming equipment. Crops must be left for waterfowl use as of November 1 annually, including the final cutting of summer produced forage crops (e.g., alfalfa) and/or a negotiated portion of cereal crops such as corn.

The intent of the water rights acquisition program (subsection 206(a) of Public Law 101-618) and language used to transfer water rights to Stillwater NWR wetlands does not allow the Service to use acquired water to produce or maintain crops. Therefore, only water sources not subject to this subsection may be used to irrigate agricultural land. Sources of water may include private water rights where a temporary transfer in place of use has been granted, in place water rights not yet transferred to the wetlands, or other sources not associated with the Stillwater NWR Water Rights Acquisition Program (WRAP EIS, USFWS 1997).

Management activities allowed for cooperator use include livestock grazing, and to a limited extent, pesticide application. All grazing strategies and pesticide applications must be approved in advance, with cooperators assuming all costs associated with management activities. Only a few pesticides have been approved for use on refuge lands.

Determination:

This use has been found compatible*/not compatible (underline one).

* This use has been found compatible assuming adherence to the stipulations identified above. All circumstances cannot possibly be anticipated, and therefore, discretion must be left up to the refuge manager to manage the environmental education and interpretation program within the framework of Alternative C of the Draft EIS.

Justification:

During the 1960's, Agricultural plantings were a regular part of wildlife management at Stillwater NWR (USFWS 1966). Winter rye and alta fescue were both planted in refuge pasture units, with goose use of these fields described as "heavy" and " all greens . . . browsed completely to the ground." Considering the cost associated with planting winter rye, it was suggested that perennial, alta fescue, be planted in the future, as goose foraging was similar between the two forage types and alta fescue did not have to be replanted annually. Agricultural practices were discontinued following this period; however, pasture reflooding was again completed during the early to mid 1980's with considerable regrowth of rye and fescue occurring in the 20 year old pastures (USFWS 1983). With the exception of cooperative farming on recently acquired lands within Stillwater NWR, no agricultural crops have been produced on Stillwater NWR since the mid 1960's.

Considering the abundance of irrigated agricultural land in Lahontan Valley, the Service cannot justify force account farming on refuge lands. This activity would be counter to Goal A under the preferred alternative which is to "Conserve and manage fish, wildlife, and their habitat to restore and maintain natural biological diversity" and in conflict with water right transfer agreements which state that water rights are to be used for "maintenance of wetlands for recreation and wildlife/storage."

However, providing forage for migratory Canada geese during the waterfowl hunting season is consistent with fulfilling international agreements with respect to fish and wildlife (Intermountain West Joint Venture 1995), therefore production of agricultural crops for wildlife purposes is consistent with Goal B of Alternative C. Considering that Service resources would not be utilized during this agricultural production, crop types would correspond to those traditionally used by Canada geese, and crops would only be planted in historically cropped areas, it is the Service's opinion that benefits to migratory bird resources outweigh conflicts relative to restoring and maintaining natural biological diversity within the confines of previously farmed areas.

The Service recognizes that some species, including Canada geese, have adapted to agriculture and, although agriculture is not a natural element of the Lahontan Valley, concessions should be made to account for wildlife populations, potentially impacted through changes in management philosophy. Additionally the Service recognizes that no agricultural fields located outside refuge boundaries, are maintained specifically for geese in a relatively disturbance free environment and that crop depredation losses relative to goose foraging on winter crops can result in economic loss to adjacent, private landowners (Sugden 1976). It is anticipated that wildlife, species diversity will remain lower on farmed lands; however, these localized impacts would be outweighed by providing undisturbed forage for herbivorous waterfowl, a missing component of the existing Stillwater NWR/Lahontan Valley habitat complex, and through fulfillment of individual species seasonal life history requirements (e.g., Canada geese, white-faced ibis, mule deer).

COMPATIBILITY DETERMINATION

Determination and Concurrence Signature Page

Refuge Determination

Prepared by: ______________________ ____________
(Signature and Title) (Date)

Refuge Manager Approval: ______________________ ____________
(Signature and Title) (Date)

Regional Office/California-Nevada Operations Office Concurrence

Refuge Supervisor: ______________________ ____________
(Signature and Title) (Date)

Refuges & Wildlife PARD: ______________________ ____________
(Signature and Title) (Date)

Geographic ARD/ CNO Manager: ______________________ ____________
(Signature and Title) (Date)

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Detailed Assessment of the Anticipated Effects of Hunting
Stillwater NWR Complex

The impacts of Alternative C's hunt program on the Service's ability to achieve refuge purposes and the Refuge System mission are evaluated in detail in the following table. Four of the five factors listed below correspond to refuge purposes, and the fifth corresponds to the Refuge System mission. Because the purposes of Stillwater NWR focus on fish and wildlife while they are on the refuge (Factors 1-3) and public uses occurring on the refuge (Factor 4), Factors 1-4 focus on the effects that occur on the refuge. Effects on flyway populations, breeding success outside of Stillwater NWR, and other larger ecosystem parameters are addressed in the context of the Refuge System mission (Factor 5). Only those components of refuge purposes that could potentially be affected by hunting are listed and "impacts" can include both negative and positive impacts.

Factor 1 is divided into several categories, corresponding to the main components of biological diversity. Biological diversity can be measured in terms of the identify and number of different species, biotic communities, and types of biotic processes, and the amount (e.g., abundance, biomass, cover, rate), distribution, and structure of each.

1. Impacts on the Service's ability to approximate natural biological diversity on Stillwater NWR, including natural levels of:
   a. species richness
   b. abundance and distribution of wildlife, including use levels (e.g., waterfowl, bald eagle use days)
   c. biotic processes, such as:
      i. migration and movement patterns (e.g., arrival and departure dates)
      ii. feeding patterns and nutritional status
      iii. production and survival rates
      iv. herbivory
   d. vegetative diversity, including structural diversity

2. Impacts on the Service's ability to provide for the conservation and management wildlife on Stillwater NWR, including:
   a. ability of wildlife species to daily secure sufficient food resources and maintain adequate nutritional status
   b. ability of wildlife species to find secure areas in high quality habitat for feeding, resting, and thermal regulation
   c. ability of wildlife to find and use high-quality breeding habitat
   d. ability of wildlife species to sustain viable populations

3. Impacts on the Service's ability to contribute toward fulfillment of International treaty obligations with respect to wildlife on Stillwater NWR, including:
   a. providing no-hunting zones and sanctuary areas for migratory birds
   b. restore and maintain natural habitat and ecosystems
   c. control or eliminate noxious weeds and abate pollution problems
   d. assuring that all uses are compatible with wildlife and biodiversity conservation

4. Impacts on the Service's ability to provide opportunities for scientific research, environmental education, and wildlife-oriented recreation.

5. Impacts on the Service's ability to contribute toward the conservation of fish, wildlife, plants, and their habitat in the United States.

Although published scientific information and locally-derived information was used in developing all compatibility determinations, there was comparative more information available for assessing the potential effects of hunting. Furthermore, given the interest in available scientific and other biological information pertinent to this issue and the requirement to provide for public review of compatibility determinations, a detailed assessment of the information is provided on the potential effects of hunting. This allowed the compatibility determinations for hunting to remain free of citations of the many pieces of information that were examined and used in the assessment. Information cited in the following table was obtained from the literature review provided in Appendix L (DeLong and Schmidt 2000) and from an analysis of 30 years of waterfowl data (Bundy 2000). These documents should be consulted for further details.

Compatibility Worksheet

Refuge Name: Stillwater National Wildlife Refuge Use: Hunting Completed by: Don DeLong Date Assessed: Draft—01/17/2000

Factor 1: Impacts on the Service's ability to approximate natural biological diversity on Stillwater NWR.			
		Will the Impacts be within an Acceptable Range?	
Element	Anticipated Impacts of the Use	(Yes/No)	Basis for Answer
a. species richness	Summary Statement: Hunting, as managed under Options 1 and 2 of Alternative C would not affect species richness. Published Scientific Information: None found to address this factor. Local Information/Observation: None available to address this factor.	Yes	The sanctuary of Option 1 and sanctuary and walk-in-only hunt area of Option 2 would likely result in at least a few individuals of each species remaining on the refuge through the hunting season.
b. abundance, use levels, distributions, habitat use	Summary Statement: Based on available information (summarized below), it is anticipated that hunting pressure on Stillwater NWR under Options 1 and 2 of Alternative C would at times lower the abundance of waterfowl using the refuge, alter their distribution, habitat use, and cause some birds to depart from the refuge prematurely. For the purposes of this analysis, it is assumed that California quail are not native to the Lahontan Valley. Therefore, the effects of hunting on their abundance and habitat use is of no concern under this element dealing with natural biodiversity. Boating, walking, and shooting throughout parts of Stillwater Marsh undoubtedly effect the distribution and habitat use of bald eagles, but waterfowl carcasses that become available during the hunting season may beneficial effects on bald eagles and other scavenging species. For most nonhunted species, the magnitude of impacts are anticipated to be less than the effects on hunted species. Published Scientific Information[A]: Numerous studies have documented the inverse relationship between the number of waterfowl using a particular area and hunting intensity (e.g., Reichholf 1973, Arctander et al. 1984, Madsen et al. 1992 as cited by Fox and Madsen 1997, Wolder 1993). Waterfowl distribution and abundance has been shown to be influenced by hunters at densities as low as 1 hunter for every 4,000 to 5,000 acres, with dabbling ducks being affected at densities as low as 1 hunter for every 1,300 acres (Mabie 1985; Madsen et al., as cited by Fox and Madsen 1997), monitoring the effects of hunter density in the walk-in-only hunt area would be imperative. Hunting intensity is not only a function of the number of hunters per unit area, but also the means by which they access the area and their ultimate distribution. For instance, boat access is a critical function of hunting intensity due to significant effects it can have on the distribution and habitat use of waterfowl and other birds (Sterling and Dzubin 1967, Bergman 1973, Speight 1973, Korschgen 1985, Skagen 1990, Kahl 1991, Bauer et al. 1992, Dahlgren and Korschgen 1992). Several studies	Yes	It is expected that the combined effects of the sanctuary, walk-in-only hunt area (Option 2), and boating restrictions would be sufficient to ensure that the effects of hunting on waterfowl abundance, use levels, and habitat use are maintained within acceptable levels. Of primary importance in answering 'yes' is the maintenance of a sanctuary encompassing high-quality feeding habitat for diving ducks, dabbling ducks, and geese, and loafing habitat. Despite the relatively small size of the sanctuary, impacts in the hunt area are anticipated to remain within an acceptable range for two main reasons. It is assumed that hunter densities would remain relatively low to moderate (e.g., 1 hunter to more than 100 acres of habitat). In part, this would require the maintenance of a walk-in-only hunt area, designed in part to provide relatively undisturbed habitat for waterfowl. In the walk-in-only hunt area, it is anticipated that hunter densities would range from no hunters on

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[A] Based on a literature review by A. DeLong and J. Schmidt (2000), found in Appendix L.

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Factor 1 (cont'd)		Will the Impacts be within an Acceptable Range?	
Element	Anticipated Impacts of the Use	(Yes/No)	Basis for Answer
	(continued) have shown that the presence of one boat can have the same effect on birds as many boats and people (Tuite et al. 1983 and Knight and Knight 1984 as cited by Kight and Cole 1995). Speed, noise, and increased access are the main factors that impact birds with respect to boats (Speight 1973, Kahl 1991, Dahlgren and Korschgen 1992, Knight and Cole 1995). Hunting intensity has been shown to result in reduced use of some areas and premature departures of migratory waterfowl (Korschgen et al. 1988, Madsen 1988 as cited by Dalgren and Korschgen 1992, Serie and Sharp 1989). In general, boating disturbs waterbirds more so than walking, but walking can also affect the distribution of other waterbirds (Burger 1981, Klein 1993). *Nontarget Species:* Nontarget species can also be affected by hunting and associated activities such as boating, walking through the marsh and riparian corridors, and shooting. Human activity, especially boating which can affect large areas in a short period of time, can disrupt bald eagle feeding activity and displace bald eagles from areas (Skagen 1980, Stalmaster 1980, Buehler et al. 1991). Although some studies have found nonmotorized boats to be most disruptive (Knight and Knight 1984), motorboats generally have a greater potential for disturbance (Tuite et al. 1983, Knight and Cole 1995). Pollution caused by boats (see Element 3.b) can impact aquatic organisms, and some of the toxins bioaccumulate (Waller et al. 1999, for review). Local Information/Observation: Analysis of 30 years of waterfowl surveys conducted by NDOW and one year of monthly waterbird inventories of Stillwater NWR (Bundy 2000) indicates that hunting activity on Stillwater NWR substantially alters waterfowl distribution. The following is a summary of some of the pertinent results of Bundy's analysis, although it should be understood that this pertains to the past 30 years and the changes under Options 1 and 2 would mediate some of these effects. Prior to the hunting season over the last 30 years, ducks used the sanctuary and open area roughly proportional to the amount of habitat in each: roughly one-third of ducks used the sanctuary (an average of one-third of the refuge's wetland habitat) during August and September. In October, the proportional use of the sanctuary increased markedly over that of August and September. An average of about 55-70% of ducks have used about 27-33% of the habitat during October-December. Of the total number of birds using Stillwater NWR and Carson Lake during the last 30 years during October-December, about 35-50% of the birds were found in Stillwater NWR's sanctuary (about 20% of the available habitat). Waterfowl numbers on Stillwater NWR (and throughout the Lahontan Valley) peak each year in October, and drop off markedly through December), but the cause of this has not been examined. Although hunting pressure may be part of the reason, it may be due in large part to a drop in food availability. The information summarized above is generally consistent with findings in the published literature. Proportionally more secure habitat containing preferred food for dabblers, either by discontinuing hunting in West Marsh (Option 1) or by establishing a walk-in-hunt area in West Marsh and Swan Lakes (Option 2) would alleviate some of these effects.		*(continued)* some days to 1 hunter per several hundred acres. Secondly, and likely a more important factor, is the implementation of boating restrictions. The identified boating restrictions are critical to maintaining impacts within acceptable levels because one motor boat can have the same effect as many people accessing a marsh by foot. Closing areas to boating can offset some of the effects of hunting (Havera et al. 1992), including effects on bald eagles. Restrictions on boats include the exclusion of boats from at least 55 percent of the marsh (including the walk-in-only area), exclusion of airboats, and restrictions to maintain low boating speeds and low noise outputs (including a 15 hp limit on motors and 5 mph speed limit). In general, impacts to nonhunted species would be less than those to waterfowl because they are not hunted and because the hunting season occurs after peak use by most of the these birds.

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Factor 1 (cont'd)		Will the Impacts be within an Acceptable Range?	
Element	Anticipated Impacts of Use	(Yes/No)	Basis for Answer
c.i. migration, movements, arrival/departure dates	Summary Statement: Based on available information, it is anticipated that hunting pressure on Stillwater NWR under Options 1 and 2 of Alternative C would at times cause some birds to depart from the refuge prematurely, thus affecting migrational movements. It is recognized that food availability also plays a key role, and may outweigh the effects of hunting pressure. Published Scientific Information: see previous block, 1.b. Local Information/Observation: see previous block, 1.b.	Yes	It is expected that the combined effects of the sanctuary, walk-in-only hunt area (Option 2), and boating restrictions would be sufficient to ensure that the effects of hunting on waterfowl migration are maintained within acceptable levels. The basis for answering 'yes' for this element is further addressed in 1.b, above.
c.ii. feeding patterns, nutritional status	Summary Statement: Based on the available information (summarized below), it is anticipated that hunting pressure on Stillwater NWR under Options 1 and 2 of Alternative C would at times cause some changes in habitat use, feeding behavior, and nutritional status of waterfowl. It may also have similar effects on other species, but this is less well understood. Published Scientific Information: Feeding patterns and the nutritional status of waterfowl has been shown to be affected by hunting activities, significantly in some cases. Hunting activity can cause birds to change feeding locations (Cronan 1957, Thornburg 1973, Madsen 1995), feed more at night (Thornburg 1973, Morton 1989a, 1989b), reduce the amount of time spent feeding (Cronan 1957, Thompson 1973, Thornburg 1973, Paulus 1984, Korschgen et al. 1985, Morton 1989a,b), and feed in lower quality habitat (Kahl 1991). Although night feeding appears to be a normal behavior of waterfowl under some situations even when not being hunted (Drabeney 1976, Jorde 1981, Bailey 1982, Baldessare et al. 1988, Jorde and Owens 1988), hunting can reduce day-time feeding and increase night-time feeding (Owen 1970, Thornburg 1973, Madsen 1988 as cited by Knight and Cole 1995, Morton 1989a, 1989b), which has the potential to adversely impact nutritional status of waterfowl (Bélanger and Bédard 1995). Some of the reasons put forth to explain why waterfowl do some of their feeding at night, even in non-hunt situations, include the availability of invertebrates not available during the day (Newell 1970), thermoregulatory benefits, and protection from diurnal avian predators. Whereas the severity of the impact of increased night feeding on waterfowl has been questioned, increased night-time feeding demonstrates a deviation from normal behavior, which inherently has at least some adverse impacts associated with it. Whereas studies have documented adverse impacts associated with nighttime feeding, no studies were located demonstrating that it does not cause adverse impacts. It is predicted that night-time feeding by waterfowl at Stillwater NWR would occur at levels higher than would occur naturally, based on studies summarized in Appendix L and the hunting pressure that occurs on the refuge. Human activity, especially boating, can disrupt feeding activity of other birds, such as bald eagles (Skagen 1980, Stalmaster 1980, Buehler et al. 1991). Wetland vegetation can be affected by motorboat activity (Sukkopp 1971 and Haslam 1978 as cited by Liddle Scorgie 1980). Use by boats with outboard motors during the nongrowing season would tend to reduce availability of submergent aquatic vegetation by cutting plants off below the water surface. However, this does not appear to be excessive at Stillwater NWR.	Yes	It is expected that the combined effects of the sanctuary, walk-in-only hunt area (Option 2), and boating restrictions would be sufficient to ensure that the effects of hunting on waterfowl feeding pattern and nutritional status are maintained within acceptable levels. The basis for answering 'yes' for this element parallel the reasons given for 1.b, above. In summary, it is anticipated that the sanctuary and walk-in-only hunt area, along with boating restrictions, would allow for sufficient resources to be made available for waterfowl such that the overall adverse impacts to the feeding behavior, habitat use, nutritional status, and overall welfare of waterfowl, while on the refuge, would be within acceptable limits. The adequacy of the sanctuary and walk-in-only hunt area to provide a sufficient amount of "secure habitat" of suitable quality on Stillwater NWR is addressed in Factor 3.a, below.

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Factor 1 (cont'd)		Will the Impacts be within an Acceptable Range?	
Element	Anticipated Impacts of Use	(Yes/No)	Basis for Answer
	(continued) Local Information/Observation: The disproportional use of the sanctuary during the hunting season (summarize in 1.b, above) suggests that hunting pressure and public-use zones (hunt area, sanctuary on the refuge have been an overriding factor influencing distribution and habitat use of waterfowl during the hunting season (Bundy 2000), rather than habitat preference. Concentrating their use inside the sanctuary during daylight hours where little of their preferred forage is found has required that they feed more at night than they may have normally. Increased emphasis on moist soil vegetation in the sanctuary and provisions to ensure secure moist soil habitat in West Marsh (Option 1) and West Marsh and Swan Lake (Option 2) would enhance the ability of dabbling ducks to fulfill their daily requirements more readily. No local data is available on the effects of hunting on nutritional status, although survey data tends to parallel scientific.		*(continued)* It is anticipated that the overall hunting pressure (including no pressure in the sanctuary) would not be high enough to increase nighttime feeding to the point that it would begin to have measurable impacts on the physiology, behavior, or migration patterns of affected waterfowl because, under Options 1 and 2, there should be a sufficient amount of secure day-time habitat.
c.iii. productivity, survival rates	Summary Statement: It is anticipated that hunting pressure on Stillwater NWR under Options 1 and 2 of Alternative C would have little if any affect on waterfowl production on the refuge the following spring, but it would slightly affect survival rates. Water pollution caused by boating is not anticipated to be high enough to have major impacts on aquatic plants, invertebrates, and other organisms. Published Scientific Information: High disturbance levels during the winter has been put forth as a possible contributing factor to lowered production and survival (Morton 1989a, Kahl 1991). Pollution caused by boating (Element 3.b) has been found to adverse impact some aquatic organisms (Waller et al. 1999 for review). Local Information/Observation: However, it is unlikely that hunting of birds on Stillwater NWR during October-January would adversely impact production of waterfowl on the refuge during the following spring and summer because most of the birds present on the refuge during hunting season do not nest on the refuge. Potential impacts to off-refuge production is addressed elsewhere (Factor 5, below). Based on records kept on harvest rates and waterfowl surveys, hunting reduces survival rates of waterfowl while they are on Stillwater NWR, although the number of birds harvested is small compared to the number of waterfowl using the refuge during the fall and winter. Potential impacts to flyway waterfowl populations is addressed elsewhere (Factor 5, below).	Yes	Hunting likely does not affect production on the refuge because most of the ducks that nest on the refuge are not present in the area during the hunting season. The killing of birds as part of the hunting experience is an acceptable impact so long as the abundance and use of the refuge by waterfowl species is not significantly impaired.
c.iv. herbivory	Summary Statement: Hunting under Options 1 and 2 would have at least some affect on herbivory rates in wetland units. To the extent that hunting pressure keeps herbivorous waterbirds out of the general hunt area, herbivory rates would be lower in the hunt area and higher in the sanctuary, given the disproportional use of the sanctuary during the hunting season. This may explain why the proportion of ducks using the sanctuary declines despite continued or varying hunting pressure. See also Element 1.c.ii.	Yes	It appears that submergent aquatic vegetation is eventually depleted during the hunting season, and although hunting may affect rates of herbivory in particular areas, this may not affect the annual consumption by waterbirds. Reduced day-time feeding may be made-up at night.

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Factor 1 (cont'd)		Will the Impacts be within an Acceptable Range?	
Element	Anticipated Impacts of Use	(Yes/No)	Basis for Answer
d. vegetative diversity, including structural diversity	Summary Statement: Based on available information, it is anticipated that hunting activities would slightly affect vegetative diversity on Stillwater NWR under Options 1 and 2 of Alternative C. Another impact of the hunt program on the Service's ability to approximate natural vegetative diversity is the flooding of moist soil units in East Pasture, which was incorporated into Options 1 and 2 of Alternative C primarily to offset impacts associated with not providing a full range of feeding habitats within the existing sanctuary. The fall flooding of East Pasture units would detract from the approximation of natural vegetative diversity in two main ways. It would produce habitat not natural to the area at that season (most of the plant species produced would be nonnative), and it would divert water away from producing or maintaining natural vegetative habitats See also Element 1.c.iv. Published Scientific information: Wetland vegetation can be affected by motorboat activity, and the effects can be positive or negative, depending on species of plant and timing of impact (Sukkopp 1971 and Haslam 1978 as cited by Liddle Scorgie 1980). Although camping has been shown to adversely impact vegetation and wildlife habitat in other areas (Little 1975, McEven and Tocher 1976), few adverse impacts would be anticipated under Options 1 and 2 because overnight stays would be restricted to a small number of designated sites all of which would have discernable boundaries, likely in already disturbed areas, and would not be located in sensitive areas. Local Information/Observation: None available on this element.	Yes	It is anticipated that enforcing a 15 hp motor limit and 5 mph speed limit and additional wetland-habitat closed to boating would maintain adverse impacts to wetland vegetation within acceptable limits. Overnight stays in designated areas would have negligible impacts on vegetation. Although flooding of moist soil units in the sanctuary could negatively affect native vegetative diversity, it would contribute positively to providing a high-quality fall and winter forage for dabbling ducks.

Factor 2: Impacts on the Service's ability to provide for the conservation and management wildlife on Stillwater NWR.

		Will the Impacts be within an Acceptable Range?	
Element	Anticipated Impacts of Use	(Yes/No)	
a. ability of each species to daily obtain sufficient food and maintain good nutritional status	Summary Statement: Based on the available information (summarized under element 1.c.ii, above, and 3.d, below), it is anticipated that hunting pressure on Stillwater NWR under Alternative C would in most cases not impair the ability of waterfowl and other birds to daily obtain sufficient food to maintain good nutritional status, but in some cases it may at least to a small degree. Hunting pressure on California quail is not anticipated to be enough to impact this element, but this would be reexamined periodically. Published Scientific Information: Summarized in Elements 1.c.ii, above, and 3.d, below. Local Information/Observation: Summarized in Element 1.c.ii, above, and 3.d, below.	Yes	It is expected that the combined effects of the sanctuary, walk-in-only hunt area (Option 2), and boating restrictions would be sufficient to ensure that the effects of hunting on waterfowl's ability to daily obtain sufficient food are maintained within acceptable levels. The basis for answering 'yes' for this element parallels the reasons given for 1.c.ii, above, and 3.d, below.

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Factor 2 (cont'd)		Will the Impacts be within an Acceptable Range?	
Element	Anticipated Impacts of Use		Basis for Answer
b. ability of each species to find secure areas in high quality habitat for feeding, resting, and thermal regulation	Summary Statement: Based on the available information (summarized under 3.d, below), it is anticipated that the hunt program under Alternative C would allow waterfowl and other birds to find relatively secure areas in high-quality habitat for resting and thermal regulation. However, it is anticipated that waterfowl and other birds would not always be able to find suitable foraging habitat in relatively secure areas throughout the hunting season. In such cases, waterfowl would have to resort to locating resting habitat or thermal cover during the day and possibly feeding at night. Published Scientific Information: Summarized in Element 3.d, below. Local Information/Observation: Several of the units in the sanctuary (e.g., Lower Foxtail) have traditionally produced excellent stands of sago pondweed and other seed-producing aquatic vegetation (Marshall 1952, Appendix G 1.8-9) that are favored by a number of waterfowl species, especially divers, and American coots (Bundy 2000). Several units in the sanctuary have ranked among the highest in terms of submergent vegetation quality (Bundy 2000). Although the wetland units in the historic sanctuary have not produced much in the way of annual seed-producing moist-soil vegetation, the use of West and East Pastures for this purpose and the addition of West Marsh to the sanctuary (Option 1) or dedication of West Marsh and Swan Lake as a walk-in-only hunt area (Option 2) would help substantially in providing a full range of feeding habitats for waterfowl in relatively secure areas. The historic sanctuary appears to provide adequate resting habitat for waterfowl and other species, but this has not been investigated. Thermal protection is likely best in the more complex portions of the marsh, including West Marsh and Swan Lake and, therefore, inclusion of these wetland units into a walk-in-hunt area or sanctuary would provide additional secure habitat for thermal protection (Bundy 2000). Several factors that tend to diminish the contribution that the sanctuary and walk-in-only hunt area make to providing high-quality, secure feeding, resting, and thermal habitat for waterfowl and other waterbirds are as follows. Because of its large size relative to the size of the sanctuary and because the potential exists to manage the regulating reservoir in conflict with sanctuary purposes, Stillwater Point Reservoir presents a potential problem. In particular, upon implementing Alternative C, using the reservoir to regulate water could at times conflict with maintaining the best possible wetland-habitat in Stillwater Point Reservoir. In the past 30 years, benefits of the reservoir to waterfowl have not compared even remotely to benefits from other sanctuary units (based on Bundy 2000). Wetland-habitat acreage in Stillwater Point Reservoir during October-December has averaged about 33-45% of the sanctuary total, but duck use has only averaged about 11-17% of the total found in the sanctuary. It is ranked among the lowest quality of all wetland units on Stillwater NWR. One benefit, however, is that it provides a loafing area for Canada geese near their feeding sites. The potential need for using Stillwater Point Reservoir as a reservoir is expected to increase as additional water becomes available for the Service. Thus, a decision is needed whether it would be managed primarily to provide sanctuary habitat for waterfowl or primarily to regulate water. Several hundred additional acres of wetland-habitat exist along Division Road, whereby waterfowl are subject to disturbance by activity along the road.	Yes	It is expected that the combined effects of the sanctuary, walk-in-only hunt area (Option 2), and boating restrictions would be sufficient to ensure that the effects of hunting on the ability of waterfowl to find secure habitat for feeding, resting, and thermal regulation are maintained within acceptable levels. The basis for answering 'yes' for this element parallels the reasons given for 3.d, below. Although hunting would affect the ability of waterfowl to locate secure areas containing high-quality feeding habitat starting at some point during the hunting season, it is assumed that the sanctuary and walk-in-only hunt area would provide an adequate amount and quality of habitat to provide for most of their needs when hunting pressure is high enough to force birds off of the general hunt area. It assumes that hunting pressure in West Marsh and Swan Lake (Option 2) would be very low, low enough such that a majority of the wetland-habitat remains undisturbed on all or nearly all days (but not necessarily the same areas every day). If these assumptions are found to not be true, implementation of further restrictions may be needed. There are no hunter density limits imposed on West Marsh and Swan Lake under Option 2., but if hunter densities exceed expectations, further restrictions would be needed.

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Factor 2 (cont'd)		Will the Impacts be within an Acceptable Range?	
Element	Anticipated Impacts of Use	(Yes/No)	Basis for Answer
c. ability of each species to find and use high-quality breeding habitat	Summary Statement: Hunting would have no effect on this element	n/a	Hunting does not occur during the breeding season.
d. ability of each species to maintain a viable population	Summary Statement: Based on the available information (summarized in Factor 5, below), it is anticipated that hunting pressure on Stillwater NWR under Options 1 and 2 of Alternative C could have a slight, unmeasurable affect on waterfowl populations in the Intermountain West. Although hunting can lead to short-term reductions in California quail populations, populations would generally rebound by the following fall, even under relatively heavy hunting pressure. Published Scientific Information: See information provided under Factor 5 for waterfowl. Several investigations have found that quail species, including California quail, can be exposed to relatively high harvest levels without any significant affect to the preceding fall populations (Glading and Saarni 1944, Parmelee 1953, Marsden and Baskett 1958, and Campbell et al. 1973, as cited in Peek 1986), which demonstrates that hunter harvest merely substitutes for some part of the inevitable natural mortality (Geis 1963, Peek 1986).	Yes	The basis for answering 'ye' for this element parallels the reasons given for Factor 5, below. Because California quail are not native to the area and because of the Service's emphasis on native species, the effects of hunting on California qual populations is most relevant to sustaining hunting opportunities on the refuge over the long term for these species.

Factor 3: Impacts on the Service's ability to contribute toward fulfillment of International treaty obligations with respect to wildlife on Stillwater NWR, including:

		Will the Impacts be within an Acceptable Range?	
Element	Anticipated Impacts of the Use	(Yes/No)	Basis for Answer
a. restoring natural habitats and ecosystems, and protecting natural landscape features	Summary Statement: Hunting would have little effect on this element. Some of the effects are discussed in element 1.d. Implementation of speed restrictions would result in few if any adverse effects of boating activity on shoreline and dike erosion. Published Scientific Information: Waves caused by boats have been shown to increase shoreline erosion (Das 1969, Garrad 1988), and reduced rates of erosion have been documented for areas in which speed and access restrictions were put in place (Bhowmik 1975). Garrad and Hey (1988) recommended reducing boating speeds to 5 mph or less to reduce riverbank erosion. This information was obtained from a review done by Waller et al. (1999).	Yes	Hunting would have few direct affects on the Service's ability to restore these parameters, especially since boating would only be permitted on about 45% of the available wetland habitat, and boaters would be required to operate boats in a way that they do not exceed 5 mph.

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Factor 3 (cont'd)		Will the Impacts be within an Acceptable Range?	
Element	Anticipated Impacts of Use	(Yes/No)	Basis for Answer
b. abating and preventing pollution	Summary Statement: Although considerable amount of the fuel used by most outboard motors is released, unburned into the water (a significant source of contamination in some areas), this would not appear to pose a significant threat to aquatic invertebrates given the relatively low number of boats on the refuge. Recognition of water contamination caused by outboard motors has increased in recent years, and motor boats are increasingly being banned or more highly restricted on lakes and reservoirs due to these concerns. Published Scientific Information: On average, about 20-30 percent of all fuel used by two-stroke engines (the majority of outboard motors) fails to combust and is flushed into the water as (EPA 1991). This means that for every five gallons of fuel and lubricating oil that is used, one gallon is released directly into the water. Losses can be as high as 55 percent (Jackivicz and Kuzminiski 1973). Contaminants include benzene toluene, ethyl benzyne, xylene, methyl tertiary butyl ether (MTBE), and polycyclic aromatic hydrocarbons (National Park Service 1999, as cited by Waller 1999). Local Information/Observations: None available on this element.	Yes	Allowing motor boats to operate on only about 45% of Stillwater Marsh would minimize water pollution from boats in many units. Furthermore, it is not anticipated that use of Stillwater Marsh by boaters would reach levels that would significantly impact aquatic organisms.
c. controlling, and preventing the introduction of, invasive non-native species	Summary Statement: Vehicles, boats, waders, and boots can all carry weed and other seeds onto Stillwater NWR from other locations, and thus the potential exists for additional nonnative species to be introduced into the marsh. Published Scientific Information: The automobile is a recognized distributor of seeds of exotic plant species (Lonsdale and Lane 1994). Local Information/Observations: The extent of the problem on Stillwater NWR is unknown. Local data on this element is unavailable.	Yes	A major purpose of Stillwater NWR is to provide opportunities for wildlife-dependent recreation. All recreation activities require access by vehicles to the marsh and access for hunting would have no more potential for weed introduction than other activities.
d. providing no-hunting zones and sanctuary areas for migratory birds	Summary Statement: Although the highest quality habitat is not provided within the sanctuary and it is not as large as possible, enhancing the habitat quality within the sanctuary and providing a minimum of 4,000 acres of sanctuary (among other similar provisions) under Options 1 and 2 is anticipated to support this obligation. Published Scientific Information: Due to the adverse impacts that can occur as a result of hunting activities (see Factors 1.b/c.i and 1.c.ii-iii/2.a), results of studies cited in Appendix L indicate that sanctuaries should be as large as possible and should contain high-quality habitat (e.g., Fox and Madsen 1997). The Service's mandate to first provide for the needs of wildlife suggests that sanctuaries encompass the best quality habitat for the migratory birds in question. Under Options 1 and 2 of Alternative C, the wetland management in the sanctuary would be modified somewhat to enhance the quality of feeding habitat therein (e.g., reestablishment of East Pasture units for fall flooding of annual seed-producing plants) and it would be supplemented by habitat in the walk-in-only hunt area. Thus, it is anticipated that the sanctuary and walk-in-only hunt area would provide wetland-habitat of sufficient quality to provide for the needs of waterfowl and other waterbirds during October-January.	Yes	Although the highest quality habitat is not provided within the sanctuary and it is not as large as it possibly could be, the sanctuary under Options 1 and 2 would support the obligation to provide no sanctuary for hunted species of migratory birds.

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Factor 3 (cont'd) Element	Anticipated Impacts of Use	Will the Impacts be within an Acceptable Range? (Yes/No)	Will the Impacts be within an Acceptable Range? Basis for Answer
	(continued) Local Information/Observations: There area several factors that would tend to hinder the Service's ability to provide an adequate sanctuary area for waterfowl and other waterbirds during the hunting season given the Service's to give highest consideration to wildlife. One element of Options 1 and 2 of Alternative C is that the highest quality habitat is located in the hunt area and some of the lesser quality habitats are located in the sanctuary. In combination, Nutgrass Lake, Goose Lake, and Pintail Bay are among the highest quality wetland units in terms of fall/winter waterfowl habitat. These units, which were identified early in the process as an ideal sanctuary, has received 60-70 percent of the waterfowl hunting use in the recent past. Because it is anticipated that the sanctuary and walk-in-only hunt areas are only marginally acceptable from this standpoint, monitoring would be necessary. At present, the only limitation to relocating or modifying the boundary of the sanctuary to incorporate higher quality habitat is resistance by special interest groups.	Yes	
e. assuring that all uses are compatible with wildlife and biodiversity conservation	Summary Statement: This is the subject of the compatibility statement that this table supports. Options 1 and 2 of Alternative C were designed to be compatible with the purposes for which Stillwater NWR is to be managed. Published Scientific Information: Refer to preceding information in this table. Local Information/Observations: Refer to preceding information in this table.	Yes	'Yes' was answered to each of the preceding questions, "Will the impacts be within an acceptable range?"

Factor 4: Impacts on the Service's ability to provide opportunities for scientific research, environmental education, and wildlife-oriented recreation, including:

Element	Anticipated Impacts of the Use	Will the Impacts be within an Acceptable Range? (Yes/No)	Will the Impacts be within an Acceptable Range? Basis for Answer
a. scientific research	Summary Statement: Waterfowl hunting as managed under Options 1 and 2 of Alternative C is not anticipated to have any negative effects on the ability to conduct scientific research. Conversely, both options would present opportunities to study various aspects of the effects of hunting on wildlife, and various public-use related questions.	Yes	There are no foreseeable adverse impacts on the Service's ability to achieve this element of the fourth purpose of the refuge.
b. environmental education and interpretation	Summary Statement: The public-use program under Options 1 and 2 would provide opportunities for environmental education and interpretation during the hunting season. The hunt area would encompass approximately 60-70 percent of the wetland-habitat viewable by the public during the hunting season in most years (Option 1) or about 90 percent (Option 2), allowing about 10-40 percent of available wetland-habitat to be viewed by the public outside of the hunt area, depending on the option selected.	Yes	Several areas would be viewable to the public, and the peak season of non-hunting visitation, including environmental education and interpretation is during the spring and summer, outside of the hunting season. Continued monitoring would be necessary.

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Factor 4 (cont'd)		Will the Impacts be within an Acceptable Range?	
Element	Anticipated Impact of Use	(Yes/No)	Basis for Answer
c. hunting and fishing	Summary Statement: The hunt program under Options 1 and 2 of Alternative C would be favorable to providing opportunities for hunting. Hunting opportunities would abound on the refuge when there is adequate water, and an additional, unique type of hunting opportunity would become available under Option 1 — walk-in-only hunting — which would provide a broader array of hunting experiences and enhance the hunt program. Fishing opportunities would not be provided, but hunting has no bearing on this.	Yes	The hunt program under Options 1 and 2 of Alternative C would be favorable to providing opportunities for hunting, which is one the wildlife-dependent recreational uses of the Refuge System.
d. wildlife observation and photography	Summary Statement: The public-use program under Options 1 and 2 would provide opportunities for wildlife observation and photography during the hunting season. The hunt area would encompass approximately 60-70 percent of the wetland-habitat viewable by the public during the hunting season in most years (Option 1) or about 90 percent (Option 2), allowing about 10-40 percent of available wetland-habitat to be viewed by the public outside of the hunt area, depending on the option selected. Additional opportunities would be available in the hunt area. Providing areas in which California quail are not hunted would provide the visiting public an opportunity to view this species more readily. Published Scientific Information: Hunting could have other effects on viewing and photographic opportunities. As noted in Appendix L, the response of waterfowl to people is intimately related to the experience of waterfowl with hunters and hunting. An example was given of waterfowl in city parks that feed from human hands, while waterfowl that experience hunting activities flush at a distance of hundreds of yards. Thus, hunting can affect experiences of refuge visitors engaging in other priority public uses of Stillwater NWR such as wildlife viewing, wildlife photography, and environmental education during the fall and winter seasons and possibly beyond. This is of consideration because most of the wetland-habitat viewable by the public during October through early to mid January are within the hunt area and effects on waterfowl in the hunt are would influence waterfowl behavior while they are in the non-hunt zone of the refuge. Although waterfowl and other waterbirds would be influenced by hunting in the hunt area, it is anticipated that they would habituate, at least to some extent, to visitor use in the non-hunt portion of the public-use area. Therefore, it is anticipated that the hunt programs as prescribed under Options 1 and 2 of Alternative C would not diminish the Service's ability to achieve this purpose of the refuge.	Yes	Several areas would be viewable to the public, and the peak season of non-hunting visitation, including wildlife viewing is during the spring and summer, outside of the hunting season. Furthermore, a number of people and interest groups noted that they did not feel there was any problem with providing both hunting and viewing opportunities in the same area. Continued monitoring would be necessary. Although waterfowl and other waterbirds would be influenced by hunting in the hunt area, it is anticipated that they would habituate, at least to some extent, to visitor use in the non-hunt portion of the public-use area. Therefore, it is anticipated that the hunt program as prescribed under Options 1 and 2 of Alternative C would not measurably diminish the Service's ability to achieve this element of the fourth purpose.

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Factor 5: Impacts on the Service's ability to contribute toward the conservation of fish, wildlife, plants, and their habitat in the United States?

Element	Anticipated Impacts of the Use	Will the Impacts be within an Acceptable Range?	
		(Yes/No)	Basis for Answer
conservation of fish, plants, and their habitat in the United States	Summary Statement: Because each refuge contributes to the conservation of fish, wildlife, plants, and their habitat in the Refuge System, all of the effects described previously affect the overall ability of the Service to achieve this fundamental mission. Providing high-quality habitat, which includes protection from disturbance, on Stillwater NWR is especially important given the significantly reduced acreage of wetland-habitat in Nevada (an estimated 80% reduction) where wetland-habitat is widely scattered. Not addressed previously were the potential effects on flyway populations, breeding success outside of Stillwater NWR, and other larger ecosystem parameters. From the standpoint of hunting on individual refuges, Flyway populations would most directly be effected by the mortality of waterfowl resulting from hunting. It is possible that hunting and associated disturbances can affect production of waterfowl in northern areas, but the potential effects of this are poorly understood. Impacts to production due to disturbance during the hunting season has recently been questioned, specifically that, although lowered nutritional status of hens during the winter maintenance period has the potential to adversely impact production in some cases, this factor is of lesser concern than the availability of high-quality breeding habitat (studies in progress in the Prairie Pothole region).	Yes	See previous answers to this question. Because Pacific Flyway harvest regulations, developed annually, are designed to ensure that viable populations of waterfowl are sustained over the long term, the hunt program under Options 1 or 2 of Alternative C would not have any measurable impacts on the Service's ability to sustain viable populations of waterfowl species so long as regulations are enforced on the refuge.

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APPENDIX P:
Scoping Report

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SCOPING REPORT

ENVIRONMENTAL IMPACT STATEMENT

for the

Stillwater National Wildlife Refuge Complex

Comprehensive Conservation Plan

and Boundary Revision

U.S. Fish and Wildlife Service

Stillwater National Wildlife Refuge
1236 Auction Road
Fallon, Nevada 89406
(702)423-5128

FEBRUARY 1998

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INTRODUCTION AND BACKGROUND

Congress passed the Truckee-Carson-Pyramid Lake Water Rights Settlement Act as Title II of Public Law 101-618 (PL 101-618) on November 16, 1990. Section 206(b) of the law designated approximately 77,520 acres of Federal land to be managed as "Stillwater National Wildlife Refuge" (Stillwater NWR). This newly delineated refuge combined with Fallon National Wildlife Refuge (Fallon NWR) and Anaho Island National Wildlife Refuge (Anaho Island NWR) comprises the Stillwater National Wildlife Refuge Complex (Stillwater NWR Complex). Section 206(b) of PL 101-618 further directs the U.S. Fish and Wildlife Service (hereafter referred to as the "Service") to recommend to Congress revisions in the boundaries of Stillwater NWR "as may be appropriate to carry out the purposes" of the refuge and provisions of subsection 206(a) of the Law.

Need for a Comprehensive Conservation Plan

A comprehensive conservation plan (CCP) is needed for Stillwater NWR Complex primarily because a plan is not in place that provides long-term direction for managing the refuge's wildlife, vegetation, habitat, public use, and cultural resources according to current management authorities.

A plan is needed that provides long-term direction for Stillwater NWR to achieve refuge purposes including the management of water being acquired for the refuge's wetlands under provisions of the Public Law 101-618. Stillwater NWR is currently being managed under a 1948 50-year agreement (Tripartite Agreement) between the Service, Nevada Division of Wildlife, and the Truckee-Carson Irrigation District. This agreement (termination date - November 1998) addresses management of Stillwater Wildlife Management Area (Stillwater WMA), of which the refuge was a part until 1990. The new management direction for Stillwater NWR is defined in the purposes for which the refuge was established (Public Law 101-618 §206(b)(2)), which are: to restore and maintain natural biological diversity, conserve and manage wildlife and their habitat, fulfill international treaty obligations with respect to wildlife, and to provide opportunities for research, environmental education, and wildlife-oriented recreation.

A plan is needed to guide the management of water that is being acquired for Stillwater NWR wetlands to encourage future annual water management plans to support refuge purposes, thus promoting long-term continuity in management to reach refuge goals. The Service is in the process of acquiring additional water and water rights in conjunction with the State of Nevada for Lahontan Valley wetlands, a major component of which is Stillwater NWR wetlands. The goal of the acquisition program is to secure enough water to sustain a long-term average of 25,000 acres of wetland habitat in the primary wetland areas of the Lahontan Valley, including 14,000 acres on Stillwater NWR (*Water Rights Acquisition for Lahontan Valley Wetlands Final Environmental Impact Statement/Record of Decision*, signed November 4, 1996). It is anticipated that a long-term average annual of 125,000 acre-feet of water will be needed, about 70,000 acre-feet of which would be used for Stillwater NWR.

Public Law 101-618 also authorizes the Service to recommend to Congress boundary revisions that would enhance the Service's efforts to accomplish the purposes for which Stillwater NWR was established. Of primary consideration will be the U.S. Bureau of Reclamation withdrawn public lands comprising Stillwater WMA (about 65,600 acres), but consideration will also be

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given to other wildlife-use areas on Bureau of Reclamation lands, Fallon NWR (about 17,920 acres), and other lands in the immediate vicinity of Stillwater NWR and Stillwater WMA. Lands of Stillwater WMA not added to Stillwater NWR will no longer be administered by the Service when the Tripartite Agreement expires in November 1998. As per Subsection 206(b)(5)(C) of Public Law 101-618, the need for retaining lands within Fallon NWR in the National Wildlife Refuge System (Refuge System) will be evaluated. Boundary-revision recommendations for Stillwater NWR, if any, are to be submitted to Congress by November 26, 1997. Unless lands within Fallon NWR are recommended for disposal from the Refuge System, management of Fallon NWR lands will be addressed in the CCP (whether Fallon NWR is retained as a separate entity of the Refuge System or its lands are incorporated into Stillwater NWR).

Neither Fallon NWR nor Anaho Island NWR have a current conservation plan. Fallon NWR was established in 1931 by Executive Order 5606 as a "...refuge and breeding ground for birds and wild animals..." Anaho Island NWR was established in 1913 by Executive Order 1819 as a "...preserve and breeding ground for native birds." Public Law 101-618 (§210(b)(2)) more narrowly defined the purpose of Anaho Island NWR, stating that it was to be managed and administered "...for the benefit and protection of colonial nesting species and other migratory birds." The Public Law also recognized that Anaho Island is part of the Pyramid Lake Indian Reservation, but that it is to be managed and administered by the Service. A memorandum of understanding between the Service and the Pyramid Lake Paiute Tribe, signed in March 1992, outlined the terms of the Service's management and administration of the island.

National Environmental Policy Act (NEPA) Documentation

The environmental analysis for the CCP and the boundary-revision of Stillwater NWR will be part of a Lower Basins EIS being coordinated and prepared by the Department of the Interior's Truckee-Carson Coordination Office (TCCO). The EIS will cover three other actions in addition to the CCP and boundary revision: revisions to Operating Criteria and Procedures (OCAP) for the Newlands Irrigation Project (Bureau of Reclamation), Cui-ui water-rights acquisitions (Ecological Services of the U.S. Fish and Wildlife Service), and a negotiated Truckee River Water Quality Settlement Agreement. The Service will assist in completing the EIS.

Purpose of the Comprehensive Conservation Plan

The purpose of the CCP for Stillwater NWR, Fallon NWR, and Anaho Island NWR (Stillwater NWR Complex) is to provide managers with a sound, long-term, workable strategy for achieving refuge purposes that is consistent with Refuge System goals, Service policy, Executive Order 12996, pertinent legislation and international treaties, and principles of biodiversity conservation and wildlife management. Within this framework, important aspects of comprehensive conservation planning at Stillwater NWR Complex will be to objectively define a clear statement of desired future conditions for each refuge and to provide the avenue for long-term continuity in their management.

Purpose of Revising the Stillwater NWR Boundary

Subsection 206(b)(5) of PL 101-618 directed the Secretary of the Interior to submit recommendations to Congress with respect to any boundary revisions that may be appropriate for carrying out the provisions of subsections 206(a) and 206(b)(2). Specifically, any revisions of Stillwater NWR's boundary are to aid efforts to achieve the purposes of Stillwater NWR and to facilitate the achievement of the 25,000-acre wetland habitat target identified in subsection 206(a).

Scope of the Comprehensive Conservation Plan

The CCP, once completed, will provide management direction for 15 years. Management objectives and strategies will be outlined within the context of a long-term vision for the refuge. For instance, long-term wetland habitat objectives will be formulated with the assumption that sufficient water is available to sustain a long-term average of 14,000 acres of wetland habitat on Stillwater NWR. However, it is possible that a sufficient amount of water will not be acquired within the 15-year planning horizon. Consequently, a phased approach will be incorporated into the water management portion of the plan, with the potential that a different set of objectives may have to be formulated to account for the different (increasing) amount of water that will be available to the refuge over time.

The CCP will define desired future conditions and outline long-range management objectives and strategies for achieving the purposes of Stillwater, Fallon, and Anaho Island NWRs. The CCP will emphasize the empirical and conceptual basis of the plan, including the field studies, principles, concepts, and professional knowledge upon which the long-range objectives and strategies are based and major assumptions that were made during plan formulation. This will facilitate the development of shorter term operational plans for individual management programs such as the annual water management plan. It will also allow future managers and planners to understand the rationale behind the plan, and, therefore, will permit educated adjustments and changes to the plan (i.e., "adaptive management"). Consequently, long-term continuity in management will be fostered.

The CCP will define long-range objectives and strategies for managing water and other habitat components, wildlife populations, public uses, commercial uses, and cultural resources on the refuges. Compatibility assessments will be part of the CCP.

Because of the long-term nature of the plan, management strategies prescribed in the CCP will be relatively broad -- 1 to 5 year operational plans will be relied upon to provide site-specific, year-to-year management direction. However, the CCP will provide the framework for developing the more detailed, site-specific operational plans for particular management programs.

Three geographic scales will be addressed in the CCP for the Stillwater NWR Complex: refuges level, regional landscape level (e.g., Lahontan Valley, Truckee-Carson River basins), and the hemispheric level. Management objectives and strategies will only be prescribed at the refuge level for Federal lands. Although management objectives and strategies will not be prescribed for areas outside the refuges, consideration of conditions and factors (e.g., ecological conditions, wildlife population status, land use practices, public issues) at the other levels will be important during the formulation of objectives and strategies for the two refuges. The CCP will explain the relationships among each of these levels, as they relate to the management of the refuges in the Stillwater NWR Complex.

Refuge Level. The CCP will prescribe long-range management objectives and strategies for Stillwater NWR, Fallon NWR, and Anaho Island NWR. Although objectives will primarily be formulated based on conditions within refuge boundaries and on management direction outlined in Public Law 101-618, other management authorities, and ecological principles, objective development will also be influenced by conditions and factors outside the refuge boundaries, as explained below.

Regional Landscape Level. Management objectives and strategies for Stillwater NWR and Fallon NWR wetlands will be formulated in light of those being developed for Carson Lake by Nevada Division of Wildlife, tribal wetlands by the Fallon Paiute-Shoshone Tribe, and with an understanding of the way that other wetlands are managed in the Lahontan Valley. Management plans for Carson Lake wetlands and tribal wetlands are currently being developed; the Service is providing expertise to the Fallon tribe in the development of their wetland management plan. Where separate management plans will be developed for each of the primary wetland areas, close communication among the responsible parties during the respective planning processes will be encouraged to foster a more coordinated approach to managing the wetlands of Lahontan Valley. Consequently, the Service will pursue coordinated development of management plans for wetlands on Stillwater NWR, Carson Lake, and the Fallon Indian reservation.

Wetland management objectives for Stillwater, Fallon, and Anaho Island NWRs will also be developed in light of the regional context within which several species of colonial-nesting birds forage and nest. For example, use of Stillwater NWR and Fallon NWR wetlands by American white pelicans, which nest on Anaho Island, is influenced by wetland conditions at the two wetland refuges. About 60 miles separate Anaho Island from Stillwater and Fallon NWRs. The combined importance of Anaho Island NWR to white pelican nesting (one of the nation's largest nesting colonies at 6,000 to 10,000 pairs) and Stillwater and Fallon Refuges to pelican foraging provides one reason why the development of management objectives for the three refuges are being carried out concurrently. In a somewhat different context, the development of objectives and strategies for managing wetlands on Stillwater and Fallon NWR should be done with the understanding that nesting populations of white-faced ibis in the Lahontan Valley are influenced by wetland habitat conditions throughout the Great Basin.

Also at the regional landscape level, management objectives and strategies for Stillwater NWR may also be influenced by issues such as mosquito control and wind erosion that are of concern to people in the Lahontan Valley. Pyramid Lake and lower Truckee River issues are being considered in developing objectives and strategies for managing Anaho Island NWR.

Hemispheric Level. Relative to shorebirds, waterfowl, and other migratory birds, consideration will also be given to conditions and factors occurring at the continental, flyway, and hemispheric levels. The Lahontan Valley wetlands became one of 15 designated sites in the Western Hemispheric Shorebird Reserve network and is recognized for it's international importance as a migratory stop and breeding area for shorebirds. It also is an important area for waterfowl that migrate through the Great Basin.

EIS Study Area. The Lower Basins EIS study area encompasses the area where direct impacts of the four Federal actions being evaluated under the EIS could potentially occur. The EIS study area thus includes the Carson River from the upper end of Lahontan Reservoir down to and including farmland in the Carson Division of the Newlands project, Stillwater NWR, Carson Lake, and Carson Sink; the Truckee River from Lake Tahoe down to and including Pyramid Lake; and the Truckee Canal and associated farmland and wetlands from Derby Dam to Lahontan Reservoir.

SCOPING PROCESS

The scoping process is an early and integral part of planning, environmental review, and documentation for the proposed CCP and boundary revision. This process encourages the public and government agencies to help identify issues and concerns that should be considered as the management plan is being developed and the Stillwater NWR boundary is assessed for possible revision.

The scoping process helps to (1) identify issues and potential impacts, and (2) identify existing information. The Service has encouraged members of the public, interest groups, tribes, Federal and State agencies, and local governments to identify major issues and concerns regarding resources that could potentially be affected by implementing the proposed actions.

On September 19, 21, 26, and 28, 1995, and March 10, 11, and 19, 1997, the Truckee-Carson Coordination Office (TCCO) held scoping meetings in Fallon, Fernley, Reno and Carson City to obtain public input on the four Federal actions being analyzed in the Lower Basins EIS, including the Stillwater NWR Complex CCP and Stillwater NWR boundary revision. The Service subsequently conducted open-house/workshops in Fallon on March 24, April 30, and July 17, 1997, and in Reno on March 25, April 29, and July 16, 1997. These workshops were held specifically to gather additional input (e.g., major issues, potential courses of action, possible impacts and mitigation) for the Service to consider during the development of goals, objectives and strategies for the CCP and during the evaluation of Stillwater NWR's boundary. Press releases announcing the workshops were issued to Reno, Carson City and Fallon news media. Comments received at the workshops were documented. In addition to the open house/workshops that were open to the public, the Service met with the Nevada Division of Wildlife and Fallon Paiute-Shoshone Tribe to obtain comments. Interested parties were invited to submit written comments.

The Service sent letters to all parties on the Water Rights Acquisition EIS mailing list asking if they would like to be placed on the CCP and boundary revision mailing list. The Service also sent letters to the landowners within the boundaries of Stillwater NWR, Stillwater WMA and adjacent areas inviting them to the workshops and/or encouraging alternatives such as phone conversations or sending written comments if they were not able to attend one of the workshops.

Planning updates were periodically sent to the mailing list CCP and boundary revision mailing list. These updates introduced and described the planning process and identified how the public could become involved. Announcements of upcoming workshops/open houses were included in these updates as well as providing an address for written comments.

OVERVIEW OF PUBLIC ISSUES AND CONCERNS

The following summaries reflect comments received during public and agency meetings as well as written comments by mail and those comments given directly to the Stillwater NWR office in Fallon either by phone or in person. Also included are comments submitted on the Draft Lahontan Valley Water Rights Acquisition Program EIS which were determined to be comments more suitably addressed in the CCP process.

Habitat

Summary of Public Concern. Comments reflected the opinions that new boundary delineations should consider inclusion of the Carson River corridor (important riparian habitat); inclusion of the dune area north of the current Stillwater NWR border; exclusion or relocation of the Navy's low-level flight pattern (northwestern corner of the Stillwater WMA); incorporation of Fallon NWR; inclusion of Pelican Island area west of Fallon NWR for potential wetland habitat; and include wetlands associated with the Oles Pond (naturally occurring wetlands). Additionally, concerns were raised that wetland habitat included within refuge boundaries (including the Canvasback Gun Club) should be evaluated as part of the 25,000 acre target established by PL 101-618; Canvasback Gun Club resources should be addressed in the CCP; and Boundary Alternative #5 (most inclusive alternative) is desired.

Other comments received: judicious management of water flows into the refuge incorporating prudent use of drainage water and spills to adequately complement fresh water deliveries is paramount for water quality as well as sustaining ample spread throughout the refuge; lands left fallow due to water acquisition procedures could be leased for farming or ranching operations - this would keep adjacent wells from drying and provide additional drain water; and compatibility of livestock grazing should be addressed within the CCP - some comments received specified using grazing as a tool, some could see no value for livestock grazing.

Plans to Address Public Concerns. The Service will assess and evaluate several different management scenarios in consideration for implementation of the water management plan. Livestock grazing will also be evaluated as to it's compatibility with refuge purposes and potential use to meet management objectives. Refuge purposes are a driving consideration for boundary revision.

Wildlife

Summary of Public Concern. Comments received reflected the following: a need for predator management to promote higher waterfowl production; personal and commercial collection of reptiles is becoming a concern in Churchill County and ways to protect these species should be discussed in the CCP; and fisheries are not a desired component of Stillwater NWR, but if restored, only those species which do not consume ducklings should be stocked.

Plans to Address Public Concern. Wildlife management is the main component for boundary revision and CCP development. All modifications and strategies will be evaluated prior to implementation.

Public Use

Summary of Public Concern. Activities such as hunting, birdwatching, camping, boating, and horseback riding currently take place on Stillwater NWR, Stillwater WMA, and Fallon NWR. Concern was expressed with respect to the continuation of these activities on Stillwater WMA lands if the area is incorporated into Stillwater NWR.

Changes from current management could have direct effects on availability and quality of public use opportunities. Specific concerns expressed were those dealing with seasonal access, visitor's center, hunting, environmental education opportunities, camping, auto touring, and fishing. Several participants remarked that the CCP needs to address a more comprehensive road system (signs and designated tour routes) along with the availability of a visitor's center and environmental education facilities. Additional facilities and a more comprehensive experience were mentioned as an means to attract more tourism as well as volunteer assistance.

Concern was also raised that the area open to hunting not be diminished during the CCP process, and that a strategy be used for the seasonal closure of certain areas or the entire marsh during the breeding season. There were also some comments urging the closure of some of the northern areas as a sanctuary. Still other comments received expressed concern that current management practices with respect to hunting should not be changed.

Several people suggested that there is no biological justification for modifying boating regulations. There could be designated open/closed areas for different types of crafts and a possible horsepower restriction.

Plans to Address Public Concerns. The Service will assess and evaluate potential impacts to current and proposed activities. The Service is exploring, with assistance from interested groups, ways to balance public uses and will assess the compatibility of public use proposed for the refuge.

Local Economy

Summary of Public Concern. One of the concerns expressed was that farmland conversion should be minimized. Another concern was the need for clarification of the boundary revision impact on private inholdings. Some also mentioned that lands acquired through the water-rights acquisition program should be added to the Stillwater NWR only if they facilitate management and that unnecessary lands should be disposed of through sale or exchange for more desirable lands. There was also interest about the fate of livestock grazing on the refuge.

Plans to Address Public Concerns. The Service will evaluate the potential consequences of the boundary revisions and CCP on the local economy. The boundary of the refuge has no effect on private inholdings - landowners have exclusive rights to their own property. The Service will include into the Refuge those lands within its boundary that are purchased through the Water-Rights Acquisition Program and dispose of, through sale or exchange, those which lie outside the boundary.

Cultural Resources

Summary of Public Concern. A comment that the fluctuation of water levels should be limited to once per year to minimize impacts to cultural resources was received.

Plans to Address Public Concern. Water management strategies will be evaluated to determine the best technique needed to promote quality habitat for wildlife with consideration given to impacts on cultural resources.

SUMMARY OF SERVICE ISSUES AND CONCERNS

This section summarizes the Service's issues, concerns and potential opportunities with respect to national wildlife refuge resources and the potential impacts from Federal actions (or no action) being considered in the Lower Basins EIS.

Wildlife, Habitat and Biodiversity Issues

Opportunities. The main opportunities that the Service foresees with respect to Stillwater NWR are the conditions that would exist by making diligent efforts toward carrying out refuge purposes, Refuge System goals, and provisions of the National Wildlife Refuge System Improvement Act of 1997. These conditions would include long-term protection of major components of the Lahontan Valley wetland ecosystem, such as Stillwater Marsh, lower Carson River, and wetlands at the delta of the Carson River, and upland habitats such as the sand dune system at the southern "shore" of the Carson Sink and a representative sample of a salt desert shrub and alkali playa complex. It would also include enhanced wetland habitat for migratory birds and other wetland wildlife, a reasonable close approximation of natural biological diversity, a properly functioning ecosystem exhibiting biological integrity and a healthy environment, and partnerships with State and non-governmental organizations aimed at restoring habitats inside and outside the refuge. The ongoing water-rights acquisition program, which has already resulted in benefits to migratory birds and other wetland wildlife, will substantially improve the Service's ability to provide quality wetland habitat, even in low water years.

Limitations and Concerns. At present, however, the conditions depicted above are not being realized within Stillwater NWR. Currently, Stillwater Marsh, the wetlands at the delta of the Carson River, two portions of the sand dune complex, and a small area of salt desert shrub are under the long-term protection of the Refuge System. Conversely, protection of the lower Carson River after November 1998 (upon expiration of the Tripartite Agreement) is unknown, major portions of the sand dune complex are not within protected areas, and very little salt desert shrub habitat is represented within areas managed for wildlife. Furthermore, wetland-habitat quality on Stillwater NWR is sub-optimal (in terms of the amount of wetland habitat, functioning of the wetland system, types of wetland habitats provided, and water quality and contaminant issues); the biological diversity within Stillwater NWR is not representative of what it would be under natural conditions; and trace elements in some wetlands have been found to be at toxic levels.

These limitations (differences between existing and desired conditions) stem from the following underlying causes existing on the refuge:

1. Changed hydrology and water quality, primarily involving reduced volume of inflow, altered timing of inflow, altered flow movement and patterns through the marsh, and elevated concentrations of dissolved solids and potentially-toxic trace elements flowing into the wetlands;

2. Prevalence, influx, and increasing populations of nonnative species, including salt cedar, tall white-top, cheatgrass, bull frogs, European carp, small-mouth bass, and European starlings (to name a few); and

3. Past and ongoing land-use practices and alterations, including year-long, excessive livestock grazing, incompatible recreational uses (human disturbance), and altered landscape (e.g., structures, dikes, deep drains, and canals).

Because these are the underlying reasons refuge purposes and other management authorities are not currently being met, they are of primary concern to the Service. One limitation to resolving these core problems is information deficits. Other factors limiting achievement of refuge purposes are due to habitat conditions off the refuge and a variety of factors throughout North, Central and South America (e.g., migratory birds).

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Public Use and Research Issues

Opportunities. The main opportunities that the Service foresees with respect to public use and research on Stillwater NWR are the conditions that would exist by carrying out refuge purposes, Refuge System goals, and the National Wildlife Refuge System Improvement Act of 1997, including opportunities for high-quality, safe experiences involving hunting, wildlife observation, wildlife photography, environmental education, and environmental interpretation that are balanced with each other and that are compatible with wildlife and habitat goals. Within this context, the Service foresees partnerships with State, Tribes, Conservation Districts, non-governmental and other organizations aimed at enhancing recreational, education, and interpretive experiences on the refuge. Opportunities for scientific research are also foreseen.

Limitations and Concerns. At present, however, the conditions depicted above are not being realized within the proposed boundary of Stillwater NWR or any of the alternative boundaries. Currently, facilities and programs for the priority public uses are inadequate. More specifically, facilities, aside from roads, are non-existent for the physically impaired; opportunities for wildlife observation and photography, and environmental education and interpretation are inadequate (and are thus not considered of high quality); and hunting is receiving an unequal emphasis of the priority public uses. Furthermore, compatibility determinations have not been completed for public uses (several uses are questionable with respect to compatibility) and mercury in some species of waterfowl exceed concentrations considered safe for human consumption, and few partnerships exist. Before opportunities for fishing could be considered, the following issues would have to be addressed: mercury contamination (public health concerns); absence of a native sport-fish; adverse impact of nonnative game fish on native fish, aquatic invertebrates, and other wildlife; ability to manage wetland units for wildlife and habitat objectives; and compatibility of fishing.

These limitations (differences between existing and desired conditions) stem from the following underlying causes existing on the refuge:

1. Habitat quality is suboptimal (causing lower densities of wildlife), including elevated concentrations of potentially-toxic trace elements (resulting in health concerns);

2. Changing public-use standards - pre-November 1998 public-use management has operated under a different set of guiding principles and standards than will post-November 1998 public use management (desired conditions), and Executive Order 12996 (signed in 1996) and the National Wildlife Refuge System Improvement Act of 1997 have changed the emphasis of public use;

3. Insufficient resources are allocated to the public-use program, including no permanent, full-time Outdoor Recreation Planner, and facilities are inadequately designed.

Because these are the underlying reasons conditions called for in refuge purposes and other management authorities are not currently being realized, they are of primary concern to the Service.

Cultural Resources

Opportunities. The main opportunities that the Service foresees with respect to cultural resources on Stillwater Refuge are the conditions that would exist by carrying out refuge purposes and provisions of the National Wildlife Refuge System Improvement Act of 1997, and other pertinent laws, including:

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1. Successful preservation of archeological resources for future scientific research.
2. Preservation of cultural resources to contribute to the Service's trust responsibility to American Indians.
3. Continued archeological research to further the goals of refuge management.
4. Integration of cultural resources education into the refuge's environmental education and interpretation programs.

Limitations and Concerns. At present, however, the conditions depicted above are not being fully realized within the proposed boundary of Stillwater Refuge or any of the alternative boundaries. Currently:

1. Looting and vandalism of archeological resources likely continues on the refuge.
2. Cultural resources management occurs on a case-by-case basis (project driven).
3. There is limited understanding of the resource base and cultural resources research on the refuge is limited.
4. Cultural resources interpretation is limited (although it is more developed than environmental interpretation).

These limitations (differences between existing and desired conditions) stem from the following underlying cause:

1. Lack of a staff cultural resource expert or someone dedicating a substantial amount of their time to cultural resources protection and management.
2. Lack of a full-time law enforcement presence.
3. Lack of funding for cultural resource management.

Other Use Issues

Opportunities. The main opportunities the Service foresees with respect to other uses on Stillwater NWR are the conditions that would exist by carrying our refuge purposes and provisions of the National Wildlife Refuge System Improvement Act of 1997, including that no incompatible uses would exist on the refuge. For example, opportunities for livestock grazing and muskrat trapping would only be provided to the extent they are used to achieve refuge goals and objectives.

Limitations and Concerns. At present, however, the conditions depicted above are not being realized within the proposed boundary of Stillwater NWR or any of the alternative boundaries. Currently, livestock grazing opportunities have been provided based on the Tripartite Agreement, but at current levels and season-of-use, appears to be causing damage to wildlife habitat; and muskrat trapping opportunities have been provided based on the Tripartite Agreement, but have not necessarily been managed as a habitat management tool.

These limitations (differences between existing and desired conditions) stem from a different set of standards that have been used, and will continue to be used until November 1998 when the Tripartite Agreement expires.

APPENDIX Q:
Mailing List

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Appendix Q:
Mailing List for the Stillwater National Wildlife Refuge Complex Planning Process

FEDERAL, STATE, AND LOCAL AGENCIES

DEPARTMENT OF THE INTERIOR
Bill Bettenberg, Off. of Policy and Analysis, Wash., D.C.
Erica Niebauer, Office of the Solicitor, CA
Patricia Port, Env. Policy and Compliance, CA
Jeff Zippin, Wash., D.C.

FISH AND WILDLIFE SERVICE
Ash Meadows NWR, Manager, NV
Bob Adamcik, Div. Refuges and Wildlife, Wash., D.C.
Tom Baca, Planning Coordinator, Region 2
Cynthia Barry, PARD-Ecological Services
Liz Bellantoni, Refuge Planning, Wash., D.C.
Carolyn Bohan, PARD-Refuges and Wildlife
Brad Bortner, Div. Migratory Birds
Chet Buchanan, Ecological Services, Reno, NV
Helen Clough, Refuge Planning, Region 7
Richard Colman, PARD-External Affairs
Denise Dachner, Sacramento NWR Complex
Desert NWR, Manager, NV
Daniel Diggs, PARD-Fisheries
Mary Jo Elpers, Ecological Services, Reno, NV
Ben Harrison, NEPA Coordinator
Jim Kurth, Chief, Division of Refuges, Wash., D.C.
Tom Larson, Division of Realty, Region 3
Ed Loth, Planning Coordinator, Region 4
Mike Marxen, Northwest Planning Office
Dave Mauser, Klamath Basin NWR Complex
Rich McDonald, Law Enforcement, ID
David McMullen, PARD-Law Enforcement
Gregg Mensik, Sacramento NWR Complex
Norm Olson, Division of Realty, Region 5
Don Peterson, NEPA Coordinator, Wash., D.C.
Ken Rice, Planning Coordinator, Region 7
Ruby Lake NWR, Manager, NV
Sheldon-Hart Mountain NWR, Manager, OR
Doug Staller, Recr., Interpretation, Educ., Wash., D.C.
Stillwater NWR, Manager, NV
Mark Strong, Sheldon NWR, NV
Robert Williams, Field Superv., Ecol. Services, Reno, NV

BUREAU OF RECLAMATION
Elizabeth A. Rieke, Area Manager, Lahontan Basin Proj.
Steve Alcorn, Deputy Area Manager, Lahontan Basin Pr.
Mike Andrews , Carson City, NV
Roger LeSueur, Fallon, NV
Tom Crawford, Carson City, NV

BUREAU OF LAND MANAGEMENT
Robert Abbey, State Director, Reno, NV
Patricia Arntz, Sacramento, California
Mark Barber, Ely District, NV
Cynthia Ellis, Reno, NV
John Singlaub, District Manager, Carson, City, NV

BUREAU OF INDIAN AFFAIRS
Robert Hunter, Superintendent, Carson City, NV
Tom Strekal

DEPARTMENT OF AGRICULTURE,
Natural Resources Conservation Service (NRCS)
Stan Boltz, Conservationist, Gardnerville, NV
Rod Dahl, NRCS, Fallon, NV
Peggy Hughes, Res. Area Conserv., NRCS, Fallon
Nicholas Pearson, State Conservationist
Herb Shedd, Rural Development, NV

USGS
Jon Nowlin, District Chief, Carson City, NV
Ken LaBinski
Gary Scoppettone, Sect. Chief, BRD, Carson City, NV

ENVIRONMENTAL PROTECTION AGENCY
Environmental Protection Agency, Carson City, NV
Carolyn Yale, CA

DEPARTMENT OF DEFENSE
Captain David Rogers, Naval Air Station-Fallon, NV
Gary Cottle, Naval Air Station-Fallon
Cliff Creger, Naval Air Station-Fallon
Ketuvali Reinbold, U.S. Army Constr. Eng. Res. IL
William Ness, Army Corps of Eng., Sacramento, CA
U.S. Army Corps of Engineers, Sacramento, CA
U.S. Army Corps of Engineers, Reno, NV

DEPARTMENT OF JUSTICE
Fred Disheroon, Washington, D.C.
Steven MacFarlane, Sacramento, CA

LOS ALAMOS NATIONAL LABORATORY
Leslie Hansen
John Hutchton

THE STATE OF NEVADA
Alice M. Baldrica, NV State Historic Preserv. Officer
Terry Bray, Nevada Division of State Parks
Steve Brown, Nevada Division of Water Resources
Terry Crawforth, Administrator, NDOW, Reno
Naomi Duerr, Nevada Division of Water Planning
Richard Heap, NDOW, Fallon
Larry Neel, Nongame Biologist, NDOW, Fallon, NV
Nevada State Library & Archives, Federal Publications
Norm Saake, State Waterfowl Biologist, NDOW
Mike Turnipseed, Nevada Division of Water Resources
Pamela B. Wilcox, Division of State Lands
Nevada State Wildlife Commissioners

COUNTIES

Bjorn P. Selinder, County Manager, Churchill County
Churchill County Board of Commissioners
Jim Curran, Churchill Co., Adv. Board to Manage Wildl.
Mike Wargo, Churchill Co. Mosquito Abatement District
Eleanor Lockwood, Churchill County Planning
Douglas County Board of Commissioners
Lyon County Board of Commissioners
Storey County Board of Commissioners
Washoe County Board of Commissioners

CITIES/TOWNS

Fallon City Council
Steve King, City of Fallon Attorney
Carson City Board of Supervisors

OTHER

Federal Highway Administration, NV
Lyman F. McConnell, Truckee-Carson Irrigation District
Terri King, Lahontan Conservation District
Lahontan Conservation District

ELECTED OFFICIALS

Ken Tedford, Jr., Mayor, City of Fallon
Willis A. Swan, Fallon City Council
Chairperson, Senate Nat. Res. Comm., Nevada State Legisl.
Marcia deBraga, Nevada Assembly
Joseph Dini, Jr. Nevada Assembly
Don Gustavon, Nevada Assembly
Lynn Hettrick, Nevada Assembly
Lawrence E. Jacobson, State Senator
Bernice Mathews, State Senator
Mike McGinnis, State Senator
Mark Amodei, State Senator
Shelley Berkley, U.S. Representative
Richard H. Bryan, U.S. Senator
James A. Gibbons, U.S. Representative
Harry Reid, U.S. Senator

TRIBAL GOVERNMENTS

Alvin Moyle, Fallon Paiute-Shoshone Tribe
Phoebe Bender, Fallon Paiute-Shoshone Tribe
Norman Harry, Tribal Chairman, Pyramid Lake Paiute Tribe
John Jackson, Pyramid Lake Paiute Tribe
Steve Kinerson, Pyramid Lake Tribe
Daryl Crawford, Inter-Tribal Council of Nevada

ORGANIZATIONS AND INDIVIDUALS

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